**Advanced Ablative TPS**

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### Introduction

**Importance of Research**

- Early NASA missions (Gemini, Apollo, Mars Viking) employed new ablative TPS that were tailored for the entry environment
- After 40 years, heritage ablative TPS materials using Viking or Pathfinder era materials are at or near their performance limits and will be inadequate for future exploration missions
- Significant advances in TPS materials technology are needed in order to enable any subsequent human exploration missions beyond Low Earth Orbit

### Objectives

- This poster summarizes some recent progress at NASA in developing families of advanced rigid/conformable and flexible ablators that could potentially be used for thermal protection
- In particular the effort focuses on technologies tailored for the entry environment

### Mars Exploration Architectures

- In May 2008 NASA senior leadership commissioned a 2-year Entry, Descent, and Landing Systems Analysis study to establish EDL technology needs

### Material Advancement Required

**Materials Research**

- Development of lighter weight thermal protection material systems is required to support either mid L/D rigid systems or hypersonic inflatable/deployable aerodynamic decelerators
- Architectures require ablative materials for aerocapture based on original geometric limitations
- Studies of much larger HiADs allow for insulative flexible materials currently being studied under Fundamental Aerodynamics (Hypersonics)

**Materials Modeling**

- Advancement in materials modeling is also required to support new TPS concepts
- Multi-layer or graded rigid ablators with varying resins
- Multi-layer ablative/insulative materials
- Ablative conformal/flexible materials

### Advanced Ablator Concepts

**Goal**

- Enable thermally optimized TPS systems that offer ability to cover large surfaces without gaps/seams

**Infusion Plan**

- Block upgrade option for NASA or COTS Multi Purpose Crew Vehicle with eventual use to enable large mid L/D concept for human Mars exploration

### EDL ETDD Efforts

- Commercially supplied TPS concepts
- Multi-layer/graded materials
- Integrated ablator/composite structures
- Screening and development through NASA EDL ETDD Program

### NASA Hypersonics Work

- In-house TPS research and development
- Multi-layer graded ablator/insulator
- Conformal/flexible ablators without seams
- Low TRL R&D through Fundamental Aeronautics Hypersonics Program

### Conclusions

- NASA has the need for new TPS and TPS architectures to enable future exploration missions
- NASA is working with industry and in-house to develop new, more complex materials and systems
- Modeling these new material and their unique behaviors will be challenging due to:
  - Varying resin systems
  - Varying materials with depth
  - FSI (fluid/surface interactions)

### Future Work

- Support for rigid TPS development of commercially supplied materials through the EDL ETDD Program is ending FY11
- NASA in-house development of will continue with focus on varying resin systems and the fiber/resin interaction

### Acknowledgments

For their contributions to this research, special thanks to:

- Michelle Munk, Dr. Anthony Calomino, Dr. Robin Beck, Dr. John Lawson, Dr. Charlie Bauschlicher, Mr. Tom Squre, Dr. Frank Miles, Dr. Susan White, Dr. Nagi Mansour- NASA Ames Research Center
- Dr. Wendy Fan, Dr. Maiwead Stackeipo, Mr. Jeremy Thornton - ERC Inc.
- Dr. Jean Lachaud -UARC/Univ. of California Santa Cruz

This work was funded by EDL ETDD Program and by the Hypersonics Project through the Fundamental Aeronautics Program