**Advanced Ablative TPS**

*Matt Gasch - NASA Ames Research Center, Moffett Field, CA*

---

**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 planetary entry missions
- In particular the effort focuses technologies required to land heavy (~40 metric ton) masses in planetary entry missions

---

**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

---

**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

---

**Rigid TPS Heating Environments**

- 8 exploration architectures identified
- 5 require Rigid TPS

---

**Rigid TPS Heating Environments**

- 8 exploration architectures identified
- 5 require Rigid TPS

---

**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 ablator with varying resins
- Multi-layer ablative/insulative materials
  - Ablative conformal/flexible materials

---

**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 (fiber/resin interactions)
- 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**

---

**EDL ETDD Efforts**

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

---

**EDL ETDD Efforts**

- Commercially supplied TPS concepts
- Multi-layer/graded materials
- Integrated ablator/composite structures

---

**NASA Hypersonics Work**

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

---

**NASA Hypersonics Work**

- In-house TPS research and development
- Multi-layer graded ablator/insulator
- Conformal/flexible ablator without seams

---

**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:

Dr. Michelle Hurvitz, Dr. Anthony Calomino, Dr. Roger Back, Dr. John Lawless, Dr. Charlie Bauschlicher, Dr. Tom Squire, Dr. Frank Miles, Dr. Susan White, Dr. Neeru Mansour - NASA Ames Research Center

Dr. Wendy Fan, Dr. Mairead Stackpoole, Mr. Jeremy Thornton - ERC Inc.

Dr. Michelle Hurvitz, Dr. Anthony Calomino, Dr. Roger Back, Dr. John Lawless, Dr. Charlie Bauschlicher, Dr. Tom Squire, Dr. Frank Miles, Dr. Susan White, Dr. Neeru Mansour - NASA Ames Research Center

Dr. Wendy Fan, Dr. Mairead Stackpoole, Mr. Jeremy Thornton - ERC Inc.

Dr. Michelle Hurvitz, Dr. Anthony Calomino, Dr. Roger Back, Dr. John Lawless, Dr. Charlie Bauschlicher, Dr. Tom Squire, Dr. Frank Miles, Dr. Susan White, Dr. Neeru Mansour - NASA Ames Research Center

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