**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 particular the effort focuses on technologies tailored for the entry environment

**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)
- 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)

**Material Advancement Required**

**Materials Modeling**
- Advancement in materials modeling is also required to support new TPS concepts
  - Multi-layer or graded rigid ablator materials
  - Multi-layer ablative/insulative materials
  - Ablative conformal/insulative 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 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 Munk, Dr. Anthony Calomino, Dr. Robin Beck, Dr. John Lawson
- Dr. Michelle Munk, Dr. Anthony Calomino, Dr. Robin Beck, Dr. John Lawson
- Dr. Michelle Munk, Dr. Anthony Calomino, Dr. Robin Beck, Dr. John Lawson
- Dr. Michelle Munk, Dr. Anthony Calomino, Dr. Robin Beck, Dr. John Lawson
- Dr. Michelle Munk, Dr. Anthony Calomino, Dr. Robin Beck, Dr. John Lawson
- Dr. Michelle Munk, Dr. Anthony Calomino, Dr. Robin Beck, Dr. John Lawson
- Dr. Michelle Munk, Dr. Anthony Calomino, Dr. Robin Beck, Dr. John Lawson
- Dr. Michelle Munk, Dr. Anthony Calomino, Dr. Robin Beck, Dr. John Lawson

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