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 technologies tailored for the entry environment
- Studies of much larger architectures require ablative materials for aerocapture based on original geometric variations, resins, and insulation systems

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 Ablative TPS
Matt Gasch - NASA Ames Research Center, Moffett Field, CA

Rigid TPS Heating Environments
- 8 exploration architectures identified
- 5 require Rigid TPS
- 2 require Rigid TPS that can handle dual pulse heating

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

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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 ablator without seams
- Low TRL R&D through Fundamental Aeronautics Hypersonics Program

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 materials 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

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