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NASA's Advanced TPS Materials and Technology Development: Multi-functional Materials and Systems for Space Exploration

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Abstract:

NASA's future missions will be more demanding. They require materials to be mass efficient, robust, multi-functional, scalable and able to be integrated with other subsystems to enable innovative missions to accomplish future science missions. Thermal protection systems and materials (TPSM) are critical for the robotic and human exploration of the solar system when it involves entry. TPSM is a single string system with no back-up. Mass efficiency and robustness are required. Integration of TPSM with the aeroshell is both a challenge and an opportunity.

Since 2010, NASA's Space Technology Mission Directorate has invested in innovative new materials and systems across a spectrum of game changing technologies. In this keynote address, we plan to highlight and present our successful approaches utilized in developing four different materials and system technologies that use innovative new manufacturing techniques to meet mission needs. 3-D weaving and felt manufacturing allowed us to successfully propose new ways of addressing TPSM challenges. In the 3-D MAT project, we developed and delivered a multi-functional TPS materials solution, in under three years that is an enabler for Lunar Capable Orion Spacecraft. Under the HEEET project, we are developing a robust heat-shield that can withstand extreme entry conditions, both thermally and mechanically, for entry at Venus, Saturn or higher speed sample return missions. The improved efficiency of HEEET allows science missions entry at much reduced G'loads enabling delicate science instruments to be used. The ADEPT concept is a foldable and deployable entry system and the critical component is a multi-functional fabric that is foldable and deployable and also functions as a mechanical aeroshell and a TPS. The fourth technology we will highlight involves felt to address integration challenges of rigid ablative system such as PICA that was used on MSL. The felt technology allows us to develop a compliant TPS for easy integration.

The above four technology developments have focused on mission infusion as the success criteria. These technologies are in different stages of mission infusion. These innovations have led to new mission concepts to be proposed in the future. In our keynote address we will present approaches we have employed throughout the project to create the bridge to transition from low TRL to mission infusion and to overcome the traditional TRL valley of death.

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