NASA STTR 2019 Phase I Solicitation

T12.05 In-situ Curing of Thermoset Resin Mixtures

Lead Center: JSC

Participating Center(s): LaRC

Technology Area: TA12 Materials, Structures, Mechanical Systems and Manufacturing

NASA has a need to significantly improve the manufacturing processes of Thermal Protection Systems (TPS) used in human rated spacecraft with the intention of reducing cost and improving quality and system performance. The fabrication and installation of current TPS are labor intensive, cost prohibitive, and result in many seams between the segments. Future human missions to Mars will require the landing of large-mass payloads on the surface, and these large entry vehicles will require large areas of TPS to protect the structure. In order to reduce the cost and complexity of these vehicles, new TPS materials and compatible additive manufacturing techniques are being developed such that the thermoset-resin based materials can be deposited, bonded and cured on spacecraft structures. Typically, thermoset resin mixtures require thermal cycles at elevated temperatures to be cured and commonly that is done in ovens or autoclaves. Technologies are sought that cure thermoset resin mixtures deposited on the flight structure without placing the structure into large ovens. Instead, the material would be cured in-situ on the structure shortly after deposition.

This subtopic seeks to develop a cost effective and modular method of curing TPS materials on Earth that could be incorporated into additive manufacturing processes. The design concept and process should be able to support curing/setting of high-temperature thermoset resin based materials deposited on composite structures. The goal deliverable for Phase II would be to demonstrate a prototype of the system.

Both Human Exploration and Operations Mission Directorate (HEO) and Science Mission Directorate (SMD) would benefit from this technology. All missions that include a spacecraft that enters a planetary atmosphere require TPS to protect the structure from the high-heating associated with hypersonic flight. Improved performance and lower cost heat shields benefit the development and operation of these spacecraft. Human missions to the moon and Mars would benefit from this technology. Commercial Space programs would also benefit from TPS materials and manufacturing processes developed by NASA.

It is desired that the Phase II deliverable be the engineering design and working prototype of the system. If the solution involves the development of a new self-curing material that meets TPS requirements, a sample or proof of concept will be required.

Expected TRL for this project is 2 to 3.

References:

- https://techcollaboration.center/workshops/advanced-manufacturing-carbon-materials-workshop/ (See presentation on Technical Challenges with 3D Printing Heat Shields)