NASA SBIR/STTR
Small Business Innovation Research / Small Business Technology Transfer

NASA SBIR 2016 Phase I Solicitation

H5.02 Extreme Temperature Structures

Lead Center: LaRC

Participating Center(s): AFRC, MSFC

This subtopic seeks to develop innovative low cost and lightweight structures for cryogenic and elevated temperature environments. The storage of cryogenic propellants and the high temperature environment during atmospheric entry require advanced materials to provide low mass, affordable, and reliable solutions. The development of durable and affordable material systems is critical to technology advances and to enabling future launch and atmospheric entry vehicles. The subtopic focuses on two main areas: highly damage-tolerant composite materials for use in cryogenic storage applications and high temperature composite materials for hot structures applications. Proposals to each area will be considered separately.

Cryogenic Storage Applications

The focus of this area is to yield material polymeric composite systems and manufacturing processes which enable the capability to store and transfer cryogenic propellants (liquid oxygen and liquid hydrogen) to orbit. Operating temperature ranges for these fluids are -183° C to -253° C. Material systems and processes proposed should be sensitive to eventual scale up and manufacturability of end use hardware. Specific areas of interest include:

- Polymeric composite systems for applications in extreme cold environments such as storage vessels and ductwork for cryogenic fluids. Performance metrics for cryogenic applications include: temperature dependent properties (fracture toughness, strength, coefficient of thermal expansion), resistance to permeability and micro-cracking under cryogenic thermal and biaxial stress state cycling.
- Reliable hatch or access door sealing technique/mechanism for cryogenic polymeric composite structures. Concepts must address seal systems for both composite to composite and composite to metal applications.

Hot Structures

The focus of this area is the development of cost effective, environmentally durable and manufacturable material systems capable of operating at temperatures from 1200° C to 2000° C, while maintaining structural integrity. Significant reductions in vehicle weight can be achieved with the application of hot structures, which do not require structurally parasitic thermal protection systems. The desired material systems are lightweight structural composites that include continuous fibers. This area seeks innovative technologies in one or more of the following:

- Material systems with significant improvements of in-plane and thru the thickness mechanical properties, compared to current high temperature laminated composites, such as stitched or 3D woven fibrous preforms.
- Decreased processing time and increased consistency for high temperature composite materials.
- Improvement in potential reusability for multiple missions.

For all above technologies, research, testing, and analysis should be conducted to demonstrate technical feasibility during Phase I and show a path towards Phase II hardware demonstration. Emphasis should be on the delivery of a manufacturing demonstration unit for NASA testing at the completion of the Phase II contract.

Phase I Deliverables - Test coupons and characterization samples for demonstrating the proposed material product. Matrix of verification/characterization testing to be performed at the end of Phase II.

Phase II Deliverables - Test coupons and manufacturing demonstration unit for proposed material product. A full report of the material development process will be provided along with the results of the conducted verification matrix from Phase I. Opportunities and plans should also be identified and summarized for potential commercialization.

References:

- Anon, “Final Report of the X-33 Liquid Hydrogen Tank Test Investigation Team,” National Aeronautics and Space Administration, George C. Marshall Space Flight Center, Huntsville, Alabama 35812, May 2000.
- Glass, D. E. “Ceramic Matrix Composites (CMC) Thermal Protection Systems (TPS) and Hot Structures for Hypersonic Vehicles,” 15th AIAA International Space Planes and Hypersonic Systems and Technologies Conference, Dayton, Ohio, AIAA-2008-2682, April 2008. (http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20080017096.pdf).