



NASA SBIR 2011 Phase I Solicitation

X5 Lightweight Spacecraft Materials and Structures

The SBIR topic area of Lightweight Spacecraft Materials and Structures centers on developing lightweight inflatable structures, advanced manufacturing technologies for metallic and composite materials, structural sensing techniques, and in-situ non-destructive evaluation systems. Applications are expected to include space exploration vehicles including launch vehicles, crewed vehicles, and surface and habitat systems. The area of expandable structures solicits innovative concepts to support the development of lightweight-structure technologies that would be viable solutions to high packaging efficiency and increasing the usable primary pressurized volume in habitats, airlocks, and other crewed vessels. Technologies are needed to minimize launch mass, size and costs, while maintaining the required structural performance for loads and environments. Advanced fabrication and manufacturing of lightweight structures focuses on the development of metallic alloys and hybrid materials, processing and fabrication technologies related to near-net shape forming. The goal is to reduce structural weight, assembly steps, and minimize welds, resulting in increased reliability and reduced cost. Research should evaluate material compatibility with forming methods and establish fundamental microstructure/processing/property correlations to guide full-scale fabrication. Laboratory scale test methods are needed to accurately simulate the deformation modes experienced in large-scale manufacturing. Polymer matrix composite (PMC) materials have been identified as a critical need for launch and in-space vehicles. The reduction of structural mass translates directly to additional performance, increased payload mass and reduced cost. PMC materials are also critical for other structures, such as cryogenic propellant tanks. Advances in PMC materials, automated manufacturing processes, non-autoclave curing methods, advances in damage-tolerant/repairable structures, and PMC materials with high resistance to microcracking at cryogenic temperatures are sought. The objective is to advance technology readiness levels of PMC materials and manufacturing for launch vehicle and in-space applications resulting in structures having affordable, reliable, and predictable performance. Practical modular structural sensor systems and NDE technologies are sought for spaceflight missions. Smart, lightweight, low-volume, and stand-alone sensor systems should reduce the complexities of standard wires and connectors and enable sensing in locations not normally accessible. NDE sensor system technology should include modular, low-volume systems and have the ability to perform inspections with minimal human interaction. Systems need to provide the location and extent of damage with the minimal data transfer between the flight system and Earth. Mission application areas include space transportation vehicles, pressure vessels, ISS modules, inflatable structures, EVA suits, MMOD shields, and thermal protection structures. Research under this topic should be conducted to demonstrate technical feasibility during Phase I and show a path toward a Phase II hardware demonstration, and when possible, deliver a full-scale demonstration unit for functional and environmental testing at the completion of the Phase II contract.

Subtopics

X5.01 Expandable Structures

Lead Center: LaRC

Participating Center(s): JSC

The SBIR subtopic area of Lightweight Inflatable Structures solicits innovative concepts to support the development of primary pressurized expandable habitat and storage modules for space exploration environments. Inflatable concepts should illustrate small efficient launch volumes and large deployment volumes. Concepts should also illustrate simple designs, efficient deployment techniques, lightweight materials, and potential for integrated hard points. Robustness, damage tolerance, and minor repair capabilities should also be considered in concept submittals. Airlock and window integration into the inflatable should also be considered.

Lightweight secondary structures for internal outfitting of the inflatable structure after deployment are also solicited. Lightweight concepts of interest include walkways, storage facilities, and hard points for utility or operational subsystems. Secondary structures should be packing and mass efficient, stiff-post deployment, redundant, modular, and multi-functional.

Research should be conducted to demonstrate technical feasibility during Phase I and show a path toward a Phase II hardware demonstration, and when possible, deliver a demonstration unit for functional and environmental testing at the completion of a Phase II contract.

X5.02 Advanced Fabrication and Manufacturing of Metallic and Polymer Matrix Composite Materials for Lightweight Structures

Lead Center: LaRC

Participating Center(s): GRC, KSC, MSFC

The objective of the subtopic is to advance technology readiness levels of lightweight structures for launch vehicles and in-space applications, by using advanced materials and manufacturing techniques, resulting in structures having affordable, reliable, predictable performance with reduced costs. Performance metrics include: achieving adequate structural and weight performance; manufacturing and life cycle affordability analysis; verifiable practices for scale-up; validation of confidence in design, materials performance, and manufacturing processes; and quantitative risk reduction capability. Research should be conducted to demonstrate novel approaches, technical feasibility, and basic performance characterization during Phase I, and show a path toward a Phase II design allowables and prototype demonstration. Emphasis should be on demonstrable materials/manufacturing technology combinations that can be scaled up for very large structures.

Materials topics should focus on lightweight monolithic metallic materials or Polymer Matrix Composites (PMC) that, in combination with design modifications, can significantly reduce structural mass. Research should include assessment of the material response to forming and joining methods and verification of post-forming properties. Also of interest are high temperature PMC materials for high performance composite structures (high temperature applications), particularly those which are compatible with current composite manufacturing techniques. High temperature PMCs should enable reduction of vehicle mass through elimination or reduction of thermal protection systems. Another area of interest covers development of lightweight damage-tolerant materials that are compatible with forming methods that can significantly reduce structural mass. Proposals to each area will be considered separately.

Fabrication technology topics should focus on near-net-shape and automated manufacturing methods, which can reduce structural weight, processing, and assembly steps, and minimize joints, resulting in increased reliability and reduced cost, and characterization of material response to forming and joining methods. Other interests include development of laboratory scale test methods to accurately simulate large scale manufacturing for use in screening material behavior. Research should include computational modeling and simulation of material behavior and testing to characterize material properties and validate manufacturing methods.

X5.03 Spaceflight Structural Sensor Systems and NDE

Lead Center: LaRC

Participating Center(s): JSC, MSFC

There is a growing use for modular/low mass-volume, low power, low maintenance systems, that reduce or eliminate wiring, stand-alone smart sensor systems that provide answers as close to the sensor as practical and systems that are flexible in their applicability. The systems should allow for additions or changes in instrumentation late in the design/development process and enable relocation or upgrade on orbit. They reduce the complexities of standard wires and connectors and enable sensing functions in locations not normally accessible with previous technologies. They allow NASA to gain insight into performance and safety of NASA vehicles as well as commercial launchers, vehicles and payloads supporting NASA missions.

There is also a need for modular/low mass/volume smart NDE sensors systems and associated software that enable effective use with minimum crew training or re-familiarization after extended periods of no use. Systems should include ability to perform inspections with minimal human interaction. These systems need to provide reliable assessments of the location and extent of damage with the minimal data transfer between vehicle and Earth. Methods are desired to perform inspections in areas with difficult access in pressurized habitable compartments and external environments. Many applications require the ability to see through conductive and/or thermal insulating materials without contacting the surface. Sensors that can dynamically and accurately determine position and orientation of the NDE sensor are needed to automatically register NDE results to precise locations on the structure. Structural design and material configurations are sought that can enhance NDE and monitoring. Advanced processing and displays are needed to reduce the complexity of operations for astronaut crews who may only use the NDE tool infrequently.