NASA SBIR 2006 Phase I Solicitation

X6 Lightweight Structures and Materials

The SBIR topic area of Structures and Materials centers on developing lightweight structures technologies to support Lunar Lander, and Lunar Habitats, with relevant technology made available to the CEV and CLV programs. Lightweight structures have been identified as a critical need since the reduction of structural mass translates directly to additional up and down mass capability that would facilitate additional logistics capacity and increased science return for all mission phases. The Lightweight Structures program utilizes and combines multi-center R&D teams into a focused activity for developing lightweight structure technology for the primary load bearing structure of the pressurized elements of the Vision for Space Exploration (VSE) program. In addition, development for non-pressurized primary structures will be considered where there is synergy with the development of the pressurized structures. The major technology drivers of the lightweight structure technology development are to significantly enhance structural systems for man-rated pressurized structures by (1) lowering mass and/or improving efficient volume for reduced launch costs, (2) improving performance to reduce risk and extend life, and (3) improving manufacturing and processing to reduce costs. This topic area is responsible for mid-level technology research, development, and testing through experimental and/or analytical validation. Subtopics in this area include Radiation Shielding Materials, Lightweight Primary Structures, and Advanced Materials.

Subtopics

X6.01 Radiation Shielding Materials and Structures

Lead Center: LaRC

Participating Center(s): ARC, MSFC

Revolutionary advances in radiation shielding materials and structures technologies are needed to protect humans from the hazards of space radiation during NASA missions. All radiation species are considered, including particulate radiation (electrons, protons, neutrons, alpha particles, light ions, heavy ions, etc.) and including electromagnetic radiation (ultraviolet, x-rays, gamma rays, etc.). All space radiation environments in which humans may travel in the foreseeable future are considered, including low-Earth orbit, geosynchronous orbit, Moon, Mars, etc. The primary areas of interest for this 2006 solicitation are: (1) radiation shielding materials systems for long duration lunar surface protection for humans; and (2) lightweight radiation shielding materials systems for short term in-space operations for humans. Specific areas in which SBIR-developed technologies can contribute to NASA's overall mission requirements for advanced radiation shielding materials and structures include, but are not limited to, the following:

- New and innovative lightweight radiation shielding materials and structures to shield humans in crew exploration vehicles, large space structures such as space stations, orbiters, landers, rovers, habitats (both rigid and inflatable concepts), spacesuits, etc. The materials emphasis is on non-parasitic radiation shielding materials, or multifunctional materials, where two of the functions are radiation shielding efficiency and structural integrity.

- Radiation laboratory and spaceflight data to validate the shielding effectiveness of radiation shielding materials and structures.
- Physical, mechanical, structural, and other relevant characterization data to validate and qualify multifunctional radiation shielding materials and structures.
- Comprehensive radiation shielding databases to enable designers to incorporate and optimize radiation shielding structural materials into space systems during all the design phases.
- New and innovative processing methods to produce quality-controlled advanced radiation shielding materials of all forms - resins, fibers, fabrics, foams, microcomposites and nanocomposites, fiber-reinforced composites, light alloys, and hybrid materials.
- New and innovative fabrication techniques to fabricate advanced radiation shielding materials into useful products and structural components.
- New and innovative manufacturing techniques to produce quality-controlled advanced radiation shielding products and structural components, including innovative scale-up methods for producing quality-controlled viable quantities of advanced radiation shielding materials and structures.
- New and innovative commercialization strategies to introduce advanced radiation shielding materials and structures into the marketplace to enable availability of the technologies for use by NASA and the space exploration community.

X6.02 Lightweight Pressurized Structures Including Inflatables

Lead Center: LaRC

Participating Center(s): GRC, JPL, MSFC

This subtopic solicits innovative structural concepts that support the development of lightweight structures technologies that could be applicable to CEV, CLV and Lunar surface landers and habitats. The targeted innovative lightweight structures are for primary pressurized structures such as cyrotanks and crewed vehicles (landers and habitats). Innovations in technology are needed to minimize launch mass and costs, and increase operational volume for minimal launch volumes while at the same time maintain required structural performance for loads and environments. Of particular interest are the following structural concepts:

- Cryotank structural systems that are low mass and minimize cryogen boil-off. These concepts can include new techniques in structural concepts, manufacturing, and incorporation of tank liners or innovative insulating materials that improve on SOA designs used today.
- Lightweight multifunctional structural systems that include radiation shielding, impact shielding, thermal management, damage tolerance and durability, and/or integral diagnostics/health monitoring capabilities are of interest if they can be developed to improve the efficiency (mass/performance) of the structural system over the parasitic systems used today.
- Inflatable structures are considered as viable technique to improve volume for crew in habitats and potentially other crewed vessels. However, areas of risk need to be mitigated to build confidence in the use of these structures. In particular, durability in the presence of micrometeoroid, orbital debris and crew load induced damage, radiation-shielding protection, equipment placement and tie down concepts, and efficient packaging concepts are of interest.

Development of concepts can include structural components, improved low cost manufacturing processes, methods of validation, and/or predictive analysis capabilities. Technological improvements that focus on risk reduction/mitigation, and development of reliable yet robust designs are also being sought under this announcement.

X6.03 Material Concepts for Lightweight Structure Technology Development

Lead Center: MSFC

Participating Center(s): GRC, LaRC

This subtopic solicits innovative research for advanced material concepts that support the development of lightweight structures technologies that should be applicable for space transportation vehicle systems, propulsion systems, and planetary access and operations. Advanced materials are targeted that could be implemented into structural and propulsion systems for CEV, CLV and lunar mission vehicles, landers, and habitats. Innovations in technology are needed to increase specific strength and stiffness, provide radiation shielding, enable thermal management, and reduce Micrometeoroid/Orbital Debris (MMOD) damage potential while maintaining safety, reliability and reducing costs.

Advanced material systems and their corresponding manufacturing and processing techniques are desired. Examples would include, but are not limited to, advanced polymer matrix, ceramic matrix, and metal matrix composites; high performance metals material systems (e.g. advanced aluminum alloys, titanium alloys, super alloys, refractory alloys); hybrid material systems, multifunctional material systems, self-monitoring and self-healing material systems; and mature applications of nano-structured materials. Processing examples would include, but not limited to, composite fiber tape placement, non-autoclave curing, ceramic processing, freeform fabrication, bonding of composites, metallic thermal spray, and friction stir welding/processing.

Development of concepts can include material system characterization, methods of validation, and/or predictive analysis methods that improve understanding of the technology to reduce risk and need for conservatism in design and demonstration of integrated system performance. Damage tolerance is a specific area of interest to include analytical tools, non destructive evaluation technology and experimental techniques. NDE methods and techniques are needed to include 3D imaging and modeling of defects, and NDE technologies for determining early degradation of composites.