NASA SBIR 2009 Phase I Solicitation

X5 Advanced Composite Technology

The SBIR Topic area of Advanced Composites Technologies (ACT) focuses on technologies to mature the use of composite structures and materials for launch vehicles and/or the lunar lander.

Organic matrix composite materials have the potential for a significant mass reduction compared to metallic materials by optimizing the structural architecture of applications including the Ares V Core Stage intertank, the Ares V Core-Stage-to-Earth-Departure-Stage interstage, the Ares V Payload Shroud, and the Altair lunar lander support struts. The major technology drivers for these applications of advanced composites technologies include large scale composites manufacturing, composite damage tolerance and detection, and primary structure durability in a lunar environment. Successful composites technologies will demonstrate concepts with reduced weight and cost with no loss in performance when compared to technologies for metallic concepts.

This Topic is to enhance and fill gaps in technology development activities in the Exploration Technology Development Program Advanced Composites Technologies Project. Areas of development in the ACT project include: materials; manufacturing; nondestructive evaluation/structural health monitoring; and structural concepts. This Topic is responsible for mid-level technology research, development, and testing through experimental and/or analytical validation.

Subtopics

X5.01 Composite Structures - Practical Monitoring and NDE for Composite Structures

Lead Center: JSC

Participating Center(s): ARC, LaRC

Orion backshell, Aries Payload fairing, and Lander struts and composite pressure vessel option, COPV and composite tankage and Habitat modules are only a few of the many weight-reducing applications for composites that need efficient and modular systems to accomplish monitoring and NDE for them to be practical.

This subtopic seeks the development of technologies to detect, locate and characterize indications of a failure far enough ahead that routine actions can be taken to rectify the situation. Perform monitoring such that models can be built of event behaviors and structural response condition can be determined. Monitoring and/or NDE changes can be made with minimum cost/operations.

Performance Goals/Metrics:

- Provide impending system failure indications with sufficient time to take action to reduce the risk of catastrophic failure;
- Increase the number of sensor locations per pound of monitoring weight by 50%;
- Decrease the system monitoring electronics weight by 50%;
- Decrease total wiring required for monitoring by 50%;
- Decrease the time to plan and install monitoring by 50%;
- Decrease the overall life-cycle cost per sensor by 50%;
- Decrease total data rate required from the sensor data acquisition location by 50%;
- Decrease time to perform NDE inspections by 50%;
- Decrease the expected cost of instrumentation changes/upgrades by 50%.

Technologies sought include: smart sensors, wireless passive sensors, flexible sensors for highly curved surfaces, direct-write film sensors, real-time compact NDE imagers for damage inspection, highly accurate defect and tool position determination.

Applications include: Advanced composite structures such as cryo-tanks, large area composites such as launch vehicle fairings, habitable volumes, hard to access/inspect composite members, as well as metallic pressurized structures of all kinds. Interior as well as exterior measurements of the pressure vessel are needed.

This subtopic is also a subtopic for the "Low-Cost and Reliable Access to Space (LCRATS)" topic. Â Proposals to this subtopic may gain additional consideration to the extent that they effectively address the LCRATS topic (See topic O5 under the Space Operations Mission Directorate).

X5.02 Composite Structures - Cryotanks

Lead Center: LaRC

Participating Center(s): GRC, GSFC, JSC, MSFC

The use of composite materials for smaller cryotanks offers the potential of significant weight savings. Composite cryotank technology would be applicable to EDS propellant tanks, Altair propellant tanks, lunar cryogenic storage tanks and Ares V tanks. A material system (resin+fiber) which displays high resistance to microcracking at cryogenic temperatures is necessary for linerless cryotanks, which provide the most weight-saving potential.

This subtopic will focus on development of toughened, high strength composite materials, because the literature indicates that they have the highest microcrack resistance at cryogenic temperatures. Greatest interest is in novel approaches to increase resin strength and/or reduce resin CTE, thereby increasing resistance to microcracking at cryogenic temperature.

Performance would be evaluated by a characterization program, which would ideally generate temperature-dependent material properties including strength, modulus, and CTE as functions of temperature. Additionally, notch sensitivity, plain strain fracture toughness, and microcracking fracture toughness as functions of temperature are desirable. Tests will need to be performed at temperatures between -273Â°C and 180Â°C to fully characterize any nonlinearity in material properties with changes in temperature.

Initial property characterization would be done at the coupon level in Phase 1. Generation of design allowables, characterization of long-term material durability, and fabrication of larger panels would be part of follow-on efforts.

X5.03 Composite Structures - Manufacturing

Lead Center: MSFC

Participating Center(s): GRC, LaRC

The SBIR subtopic area of Composites Materials and Manufacturing centers on developing lightweight structures using advanced materials technologies, and new manufacturing processes. The objective of the subtopic is to advance technology readiness levels of composite materials and manufacturing for Ares launch vehicle applications resulting in structures having consistent, predictable response.

Areas of interest include: polymer matrix composites (PMCs), large-scale manufacturing; innovative automated processes (e.g., fiber placement); advanced non-autoclave curing; bonding of composite joints; and damage-tolerant/repairable structures.

Performance metrics include: achieving adequate structural and weight performance; analysis supported by test approach; manufacturing and life-cycle affordability; ability to demonstrate capabilities at the laboratory scale and confidence for scale-up; validation of confidence in design, materials performance, and manufacturing processes; quantitative risk reduction capability; minimum sensitivity and maximum robustness for operability.

Lightweight structures and advanced materials have been identified as a critical need since the reduction of structural mass translates directly to vehicle additional performance, reduced cost, and increased up and down mass capability.

Research should be conducted to demonstrate technical feasibility during Phase 1 and show a path toward a Phase 2 prototype demonstration. Demonstrate manufacturing technology that can be scaled up for very large structures.

This subtopic is also a subtopic for the "Low-Cost and Reliable Access to Space (LCRATS)" topic. Â Proposals to this subtopic may gain additional consideration to the extent that they effectively address the LCRATS topic (See topic O5 under the Space Operations Mission Directorate).