NASA SBIR 2019 Phase I Solicitation

Z4.03 Lightweight Conformal Structures

Lead Center: LaRC

Participating Center(s): MSFC

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

Design and Manufacturing of Conformal Structures

Affordable space exploration beyond LEO will require innovative lightweight structural concepts. Conformal structural designs have the potential to enable not just mass savings, but also packaging efficiency in high center of gravity design concepts through advanced lightweight materials used to allow efficient integration of multifunctional structural elements. Examples of concepts of interest are non-cylindrical, non-spherical pressure vessels including but not limited to toroidal designs, suitable for storing cryogenic liquids or as habitable volumes. Successful demonstration of the manufacturability of such complex shaped pressure vessels can influence spacecraft designs.

Phase I of the award should describe proposed structural design concepts, an assessment of the manufacturability of the proposed structures and a systems benefits study to demonstrate mass and cost savings that can be achieved for Lunar and/or Mars missions. Designs where the pressure vessel is part of the structural load path are of interest. Potential applications anticipated for the successfully demonstrated concepts include lunar landers, Mars landers, habitat modules and ascent vehicles. Phase II will include a manufacturing demonstration of the design proposed in Phase I on a scale that is representative of full scale manufacturing challenges. Advanced materials of interest for the structural design and manufacturing include but are not limited to standard carbon fiber, thin ply laminates, carbon nanotube composites and hybrids of suitable advanced materials. Fabrication approaches such as tow steering and tailoring of hybrid materials to meet design requirements of application are of particular interest.

Scaled prototype demonstrations should address manufacturing challenges that are anticipated in the full scale design.

Relevance to NASA

This topic fits under STMD. It is supported by the Lightweight Structures and Materials PT and bridges advanced materials and manufacturing.

Potential users of successful demonstration of the concept include NASA and Commercial Space companies.

References:

- Rivers, H. K., “Cryogenic Tank Trade Study for Reusable Launch Vehicles”, AIP Conf. Proc., 458, 1075

(1999).
- Hu, H., Li, S., Wang, J. and Zu, L., "Structural Design and Experimental Investigation on Filament Wound Toroidal Pressure Vessels," Composite Structures, 121, pp. 114-120 (2015).
- Fowler, C. P., Orifici, A. C., and Wang, C. H., "A Review of Toroidal Composite Pressure Vessel Optimisation and Damage Tolerant Design for High Pressure Gaseous Fuel Storage," International Journal of Hydrogen Energy, 41, pp. 22067-22089 (2016).