NASA STTR 2017 Phase I Solicitation

T12.03 Thin-Ply Composites Design Technology and Applications

Lead Center: LaRC

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

The use of thin-ply composites is one area of composites technology that has not yet been fully explored or exploited by NASA. Thin-ply composites are those with cured ply thicknesses below 0.0025" and commercially available prepregs are now available with ply thicknesses as thin as 0.00075". By comparison, a standard-ply-thickness composite would have a cured ply thickness of approximately 0.0055". Thin-ply composites hold the potential for reducing structural mass and increasing performance due to their unique structural characteristics, which include (when compared to standard-ply-thickness composites):

- Improved damage tolerance.
- Resistance to microcracking (including cryogenic-effects).
- Improved aging and fatigue resistance.
- Reduced minimum-gage thickness.
- Increased scalability.

These characteristics can make thin-ply composites attractive for a number of applications. For example, preliminary analyses show that the notched strength of a hybrid of thin and standard ply layers can increase the notched tensile strength of laminates by 30%. The resistance to microcracking makes thin-ply composites an excellent candidate for a deep-space habitation structure where hermeticity is critical. Additionally, since a deep-space habitat may need to be pre-positioned in space for a long period of time prior to crew arrival, the enhanced aging and fatigue resistance and resistance to cryogenic-induced microcracking will also be a benefit. Finally, since the designs of these types of pressurized structures are typically constrained by minimum gage considerations, the ability to reduce that minimum gage thickness offers the potential for significant mass reductions. For these reasons, NASA is interested in exploring the use of thin-ply composites for applications requiring very high structural efficiency, and for pressurized structures (such as habitation systems and tanks) for deep-space exploration systems. There are many needs in development, qualification and deployment of composite structures incorporating thin-ply materials – either alone or as a hybrid system with standard ply composite materials. The particular capabilities requested for in a Phase I proposal in this subtopic are: initial process development in using thin-ply prepregs for component fabrication using automated tape layup or other robotic technologies, contributing to the development of the design and qualification database though testing and interrogation of the structural response and damage initiation/progression at multiple scales including evaluation of environmental durability and ageing, and/or analysis and design tool validation and calibration to ensure that the technology to appropriately design and certify thin-ply composite components is matured sufficiently to be used for NASA applications. The intention of a Phase II follow-on effort would be to develop or to further mature the necessary design/analysis codes, and to validate the approach though design, build, and test of an article representative of the component/application of interest to NASA.