NASA SBIR 2017 Phase I Solicitation

H4.01 Damage Tolerant Lightweight Pressure Structures

Lead Center: JSC

Technology Area: TA6 Human Health, Life Support and Habitation Systems

Damage to and the resultant leakage of the suit structure is a criticality 1 failure that could result in loss of mission or life. NASA is striving to build a robust suit structure that can withstand the wear and tear related to exploration of a planetary surface. A highly mobile exploration spacesuit must have lightweight and robust hard upper torso. Hard upper torsos are used on the current Extravehicular Mobility Unit systems and desirable for the future because they are robust structures that require little maintenance, they provide simple and robust interfaces with the portable life support system, and they create a consistent and well sized structure for the mobility joints.

On recent development of the Z-2 space suit, NASA evaluated the use of carbon fibers, fiberglass, and kevlar composite structures to push the state of the art for a complex geometry, lightweight, and damage tolerant hard upper torso structure. Development included evaluation of various lay-ups, material combinations, and polymer systems. The end product was a hybrid composite structure of carbon and fiber glass composite. The hybrid structure was able to withstand impact energies around 100J.

NASA is interested in developing an innovative, new structure that is even more robust to impact and can maintain a low leakage level or re-seal the pressure structure after impact or damage. Hybrid laminates, materials, and construction methods should be considered to optimize toughness and damage tolerance (strength and durability). Special consideration should be given to select materials and configurations which lend themselves to manufacturability to complex shapes and repair-ability. NASA has also investigated the use of thin films on pressure vessels to make a composite structure more robust to damage and leakage. Mechanical strength of the selected materials should be characterized in both the “pristine” and “damaged” (after impact) condition, including Tension, Compression, and Interlaminar shear.

Performance targets:

- No leakage after Low Velocity Impact (LVI) of 300J of energy using ASTM D-7136 impact test with 2" diameter steel impactor and impact velocities of less than 15 ft/s.
- Structure density of less than 1.7 g/cm3.
- Primary structure and sample thickness of 0.125" or less.

Reference:

Ross, A., Rhodes, R., Graziosi, D., Jones, B., Lee, R., Haque, B., and Gillespie Jr., J., “Z-2 Prototype Space Suit Development”, ICES-2014-091, 44th International Conference on Environmental Systems, Tucson, AZ, July 2014.