NASA SBIR 2018 Phase I Solicitation

H7.01 Development of Higher Strength Feedstocks for In-Space Manufacturing

Lead Center: MSFC

Participating Center(s): LaRC

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

There is aÂ substantial rift between the properties of 3D printed thermoplastics (that can be produced with the current printers on the International Space Station)Â and the aerospace metals traditionally used in critical space systems.Â However, processes compatible with metals are more challenging from the perspective of operations in the space environment, often having volumes, powers, and safety hazards that may be incompatible with ISS requirements.Â As an alternative to adapting traditional AM of metals process to microgravity, this topic seeks development of higher strength feedstocks compatible with the FDM process that would uniquely enable NASA applications, facilitating sparing and/or palliative repair scenarios (the latter is where FDM would provide a stopgap solution until a more permanent fix could be developed).Â This work also has clear terrestrial benefits, as it stands to stands to significantly enhance the properties achievable with FDM techniques and expand the use of FDM processes for manufacturing beyond low-criticality applications.Â Proposers must clearly state how their development work under this opportunity advances the state of the art and enables new applications of AM.

This SBIR subtopic is intended to investigate development of materials and/or post-processing techniques that will:Â

- Narrow the gap between the properties of materials produced using FDM techniques and metals.
- Result in much higher strength plastics with isotropic properties and improved dimensional tolerances.
- Homogenize material by reducing presence of pores.Â

The solution may be obtained by a variety of approaches, including but not limited to:Â

- Novel post-processing or heat treatment techniques.Â Any techniques developed must be adaptable to the microgravity environment of ISS.Â Post-processing techniques must also preserve the characteristic dimensions of the part.
- Incorporation of nano or microfibers into filament feedstock.
- Benchtop materials development of high strength feedstock materials that are also extrudable with FDM.Â Feedstock materials which incorporate in-situ materials (such as those found on a planetary surface) and/or materials which represent polymer trash recyclables are of strong interest.
- Materials testing activities must be undertaken to demonstrate and quantify improvements in mechanical properties, densification, and dimensional accuracy possible with a proposed approach. Complementary modeling efforts are not required, but will be value added in establishing predictive relationships between processing conditions and material outcomes.Â

Phase I SBIR is a feasibility demonstration and should provide:Â

- Development and implementation of new materials in FDM systems that represent a significant improvement over current material options.
- Materials testing and characterization to quantify material improvement over traditional FDM techniques or FDM manufactured material in the as-built condition.
- Proposed design approach for integrating methods developed into current or future ISM payloads for FDM as well as ground based machines and processes.
- Verification that materialÂ approaches or exceedsÂ key mechanical performance targets for polymeric feedstocks sought under this opportunity: tensile strengthÂ of at leastÂ 200 MPa, specific strength of at least 100 kN-m/kg, Poisson's ratio of 0.20-0.45, and fracture toughness of at leastÂ 5 MPa/$m^{1/2.}$ Ability to meet these requirements will be demonstrated as part of the materials development activities in Phase I.