Microgravity fabrication of freeze-cast titanium foams

Problem Statement

- Space manufacturing of structural materials poses numerous advantages for space exploration including decreased launch costs and the capability of constructing structures in a space-based environment that are too large for launching.
- This research serves to utilize a test-flight environment to demonstrate the feasibility of producing near net-shape structural materials.
- This research will improve a low-cost, scalable technique for the fabrication of titanium foams with desired architectures.

Technology Development Team

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Proposed Flight Experiment

Experiment Readiness:

- The payload is currently fully operational and ready for flight.

Test Vehicles:

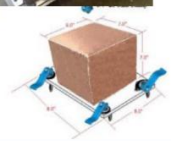
- Parabolic flight

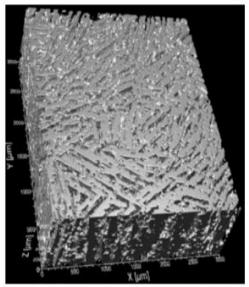
Test Environment:

- Two parabolic flights consisting of 30 parabolas each; All parabolas consisting of near zero-g loads.

Test Apparatus Description:

- The experimental apparatus consists of three main subcomponents: (i) a cooler which houses liquid samples prior to freezing, (ii) a copper block utilized as a freezing substrate, and (iii) a freezing box utilized to store solidified samples.





Technology Maturation

- We have successfully demonstrated the freeze-casting technique for titanium foam fabrication in ground-based operations; this technology is currently categorized as TRL 5.
- This technology will reach TRL 6 after demonstration in a microgravity environment.
- TRL 6 will be achieved by December 2015. Subsequent advancement will be achieved through demonstration on the ISS.

Objective of Proposed Experiment

- Utilize the test flight environment to demonstrate the feasibility of employing freeze-casting for space-based manufacturing of near net-shape structural materials.
- Utilize a microgravity environment to solidify aqueous slurries of titanium particles for the purpose of manipulating microstructural characteristics that will lead to improved mechanical properties. Elucidate gravitational influences on solidification behavior.

Technology Areas: 10.1.1 (Nano) Lightweight materials and structures, 12.2.5. Innovative, multifunctional concepts, 12.2.1. Lightweight structures, 12.2.2. Design and certification methods.

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