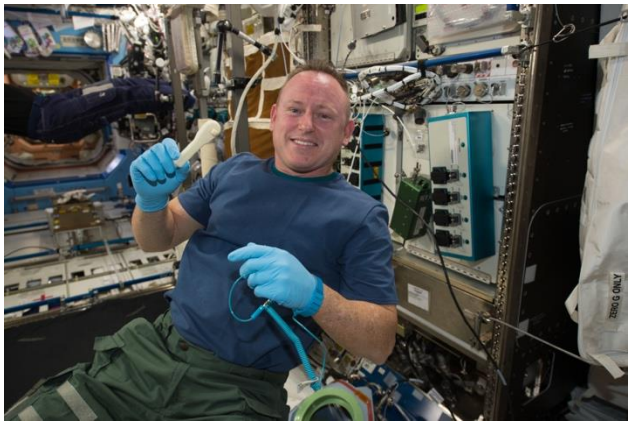
On-Demand Additive Manufacturing for Deep Space



Name of Technology:
Inability to fabricate spare parts, replacement units, specialty tools in situ (on-demand manufacturing)

Participating NASA Centers:
MSFC (Lead); GRC, LaRC,

Technological Area:
H7.02 In-Space Manufacturing of Precision Parts

Vision for the Technology:
NASA needs the ability to fabricate parts and tools on-demand for on-orbit or Deep Space missions. Crews will need the ability to perform additive manufacturing with multi-materials printing including polymers, metals, and electronic materials. Manufacturing processes such additive manufacturing, machining, and joining must all be developed for autonomous or semi-autonomous operations to meet the needs of everyday life in space. In addition, an inspection system is needed to determine if the part manufactured is suitable for its purpose.

Challenges:
Presently, crews don't have capability to fabricate spare parts, replacement units, and create specialty tools on-demand except in small demonstration components fabricated from polymers. Furthermore, there are no inspection system to provide information on the manufactured part that can be assessed to determine if the part is suitable for use.

Structures and systems will require repair, maintenance, and upgrades for a sustained human presence.

NASA Seeks to Meet the Following Specs:
An additive manufacturing system that can print parts on-demand that include metals, polymers, and electronics. Along with an inspection capability to assess the quality of the manufactured part and give confidence in the integrity of the component.

Key performance parameters:
- Instantaneous power draw below 2 kW
- Multi-materials capability
  - 2 materials (with at least one a metal)
  - Goal: 3 materials (with at least two separate metal alloys)
- Fabrication of single layer electronic devices with a goal of multilayer device fabrication
- Printed electronics:
  - Electronic feature resolution: 300 microns
  - Goal resolution: 100 microns
- On-demand monitoring or volumetric inspection resolution of less than 1 mm

Overview of Student Project:
NASA seeks to have capability to fabricate spare parts, replacement units, and create specialty tools on-demand while on-orbit and/or Mars or the moon. Additive manufacturing requirements are to have multi-materials printing including polymers, metals, and electronic materials. Inspections systems of the parts fabricated are needed as well.

Innovative Areas Student Projects Can Address:

- Develop multi-material additive manufacturing
- Develop inspections systems to validate fabricated parts

Project Phases

I. Conceptual design and analytical analysis and characteristics

II. Prototype in lab environment

Research Funded by NASA on this Topic:

Proposal Number: 11-2 O3.02-9753
ISS Additive Manufacturing Facility for On-Demand Fabrication in Space

Proposal Number: 04 X1.01-8632
In Situ Manufacturing of Plastics and Composites to Support H&R Exploration

Proposal Number: 22-1- Z4.07-2655
Solar On-orbit Welder for Assembly, Repair, and Manufacturing

Proposal Number: 22-1- Z8.10-1283
On Demand Printing of Stretchable Electronics

Proposal Number: 16-1 H1.01-8453
ISP3: In-Situ Printing Plastic Production System for Space Additive Manufacturing

References:

H7.02 In-Space Manufacturing of Precision Parts

H7.01 In-Space Manufacturing of Electronics and Avionics

Z4.07 Advanced Materials and Manufacturing for In-Space Operations

H5.03 Advanced Fabrication and Manufacturing of Polymer Matrix Composite (PMC) Structures

Z3.03 Development of Advanced Joining Technologies, Large-Scale Additive Manufacturing Processes, and Metal Recycling Technologies for On-Orbit Manufacturing

Z3.04 Autonomous Modular Assembly Technology for On-Orbit Servicing, Assembly, and Manufacturing (OSAM)

OSAM-224- "Development of on-orbit manufacturing capability for printed electronics."