IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Structures III Design, Development and Verification (Orbital infrastructure for in orbit service & manufacturing, Robotic and Mechatronic systems, including their Mechanical/Thermal/ Fluidic Systems) (3)

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TECHNOLOGY DEMONSTRATOR FOR INFINITE LENGTH ON-ORBIT PRINTING (ILOOP)

Abstract

In-space manufacturing (ISM) has been conceptualized as a promising approach to establish in-orbit sustainability. ISM enables development and maintenance of new spacecraft classes with reduced complexity, purpose-optimized systems, and maximized resource efficiency. Additive manufacturing (AM) is particularly attractive for ISM due to its inherent flexibility and low waste. So far in-orbit AM has been confined to the 3Dprinting of small components, housed within the controlled environment of the International Space Station (ISS). Large-format production beyond the confines of the ISS could unlock the full potential of ISM. To realize this, a fundamental investigation probing the feasibility of large-scale in-orbit 3D printing is being conducted.

A scientific CubeSat payload is being developed to demonstrate infinite length on-orbit printing (iLOOP) of meter-scale, functional load-bearing structures in space-representative environment. The iLOOP concept combines a Fused Filament Fabrication (FFF) setup with a conveyor belt substrate within CubeSat infrastructure to manufacture (infinitely) long, customizable, space-compatible thermoplastic structures in low Earth orbit. Specifically, space-compatible thermoplastics (e.g. PEEK, PEKK, PEI, etc.) are being investigated due to their high strength, large operational temperature range, resistance to radiation and atomic oxygen corrosion, and low outgassing.

An exhaustive, fundamental, parametric study, funded by the German Space Agency under the German Kleinsatelliten-Initiative (DLR - small satellite initiative), is being conducted at the Institute of Space Systems (IRAS) at TU Braunschweig in collaboration with ExperimentalRaumfahrt-InteressenGemeinschaft e.V. (ERIG), to develop a 3D printer capable of manufacturing meter-scale, thermoplastic samples on a conveyor belt substrate in space representative environment.

Equipped with a print-head tested to temperatures of up to 400 C and a heated Polyimide conveyor belt, this technology demonstrator is capable of printing high-performance thermoplastics. It is designed

to be compatible with a space representative environment, including vacuum. Furthermore, comprehensive attention has been given to both thermal and power management aspects. Complementing the demonstrator, an open-source slicer software has been adapted for belt-printing.

Upon establishing the feasibility of process via the first technology demonstrator, the printer will be miniaturized to a CubeSat form factor. A payload derived from this second demonstrator is planned to be launched into low Earth orbit in a follow-up project, to further demonstrate the feasibility of this concept beyond laboratory settings.