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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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GENERATIVE IN-SPACE MANUFACTURING OF LARGE SPACE STRUCTURES USING FIBRE-REINFORCED PHOTOPOLYMERS

Abstract

The Munich University of Applied Sciences (MUAS) is currently researching an In-Space Manufacturing (ISM) process to generatively produce large structures out of fibre-reinforced photopolymer directly in space. Unlike most conventional Additive Manufacturing (AM) methods, that manufacture layer-by-layer, this process is able to create three-dimensional structural elements in one continuous movement. The research is building up on parabolic flight experiments performed in 2020 using liquid photopolymer as manufacturing material. During these experiments the effects of different gravity levels on the generative process were investigated. Further research on the ISM process was conducted with an experiment under vacuum and microgravity conditions that was launched with a sounding rocket in 2022. During the microgravity phase three samples out of liquid photopolymer were produced and subsequently investigated on the effects of the space-like conditions.

This paper describes the results of the research on implementing different fibre types into the MUAS ISM process. The influence of the implemented fibres on the driving extrusion parameters and material properties is investigated and compared to the findings from the previous experiments. Finally, an outlook is given on an upcomming sounding rocket experiment in which fibre-reinfoced photopolymer samples are to be extruded under microgravity and vacuum.

The development of large space structures nowadays is driven by the limited space inside rocket fairings and the high loads occurring during a rocket launch. The limit of space inside the fairing results in complex folding or rolling techniques and technically demanding Hold Down and Release Mechanisms (HDRMs). The high launch loads lead to an overdimensioning of space systems comparing it to a system design for the much lower operational loads. ISM of such large space structures using fibre-reinforced photopolymers circumvents the two aforementioned challenges. Photopolymers can be stowed in liquid form in tanks, which enables the highest possible packing rate and thus utilizes the fairing space in the most efficient way. Therefore, structure folding is obsolete and the need for HDRMs is reduced. Transporting the liquid material for a large structure to space enables designing it to its operational loads that occure during the mission phase in orbit and avoids overdimionsing. This saves again space inside a rocket fairing and enables even larger space structures or additional payloads.