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AIMIS - ADDITIVE MANUFACTURING IN SPACE BY EXTRUSION OF UV-CURABLE POLYMER RESIN

Abstract

In-Space manufacturing of lightweight structures is a key technology for enabling the cost-effective fabrication of large orbital and planetary systems. Latest advances in generative manufacturing indicate the potentials of these technologies for in-space manufacturing. However, Fused Filament Fabrication methods, based on extrusion of thermoplastic filaments, suffer from extensive power requirements, high complexity and difficult thermal control. The AIMIS Student Team at Munich University of Applied Sciences developed a method for fast and power effective manufacturing of large space structures by extrusion and transient UV-curing of polymer resins. This type of plastic cures under the influence of UV light. With the proposed method, not only the consumption of electrical energy for the manufacturing process is manageable, but also the creation of excessive heat during curing is very limited. The method will be tested and verified by an experiment on a single-stage REXUS sounding rocket. The launch opportunity was granted by the REXUS program, which allows university students across Europe to carry out scientific and technological experiments on research rockets and will take place in March 2020 in Kiruna, Sweden.

The rocket will carry the AIMIS experiment to a height of 90 km and provide microgravity and vacuum conditions for approximately three minutes. During this time, a photopolymer will be extruded from several containers and cured immediately after extrusion by UV-C light. This process will create continuously cured rods of 5mm diameter and approximately 100mm length. The rigid rods are encapsulated to survive the re-entry of the rocket and landing. Expected results include self-supporting polymer rods and a stable manufacturing process for photoreactive polymers. The results of the AIMIS experiment shall serve as a basis for future experiments, for example, by a better definition of requirements for the polymer, possible fiber reinforcement or creation of more complex truss structures. A stable manufacturing process could open the possibility to produce large-scale components and structures directly in space, omitting the limitations of size and shape set by launch loads and shroud volumes of space transportation

systems. We present the theoretical background, the experiment design and first ground test results of the proposed in-space manufacturing process.