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IN-SPACE MANUFACTURING OF EXTERNAL SATELLITE STRUCTURES: A REVIEW OF EXISTING CONCEPTS AND DISCUSSION OF THEIR FEASIBILITY

Abstract

In-space manufacturing of external satellite structures is expected to outperform conventional deployable structures, which generally suffer from severe limitations: long and high-cost development phases, oversized elements to survive the high launch loads, mechanical complexity as well as constraints to the maximum structure size due to the limited volume in a satellite. In-Space Manufacturing (ISM) and, more specifically, Additive Manufacturing (AM) offer a solution to mitigate these issues. Several companies and universities have already recognized this opportunity and started to investigate or develop ISM technologies with the aim to produce external satellite structures directly in orbit. This paper will therefore present the underlying technologies being worked on, the materials used, its various applications as well as the presumed Technology Readiness Level (TRL) of the single developments. The Munich University of Applied Sciences (MUAS) together with the deployable structure specialist Deployables Cubed GmbH (DcubeD) has also been researching and developing its ISM technology. Unlike other approaches, this technology is based on the direct robotic extrusion of photopolymers (DREPP). Liquid resin is continually feed into a nozzle, which is surrounded by several UV LEDs. Upon actuation of the LEDs, the resin cures instantly and can so be used to fashion solid closed section rods for example. This technology, however, offers advantages, but also difficulties. For instance, the printing material can be stored in a very confined space and cured to a solid element by using a small amount of energy. While photopolymer is relatively easy to handle on Earth, it is expected to be much more challenging in space. This assumption is mainly supported by high temperature differences, high UV radiation from the sun and the vacuum environment. However, experiments on parabolic flights have shown that the absence of gravity has a positive effect on the process. In this paper, the single approaches will be compared with the DREPP technology and discussed afterwards. This paper will conclude with an overview of future research activities to take place in this field at MUAS and DcubeD.