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Manufacturing and industrialization for Launch Vehicle and Space Vehicle Structures and components (High volume production, industrialization, automatization and digitalization) (7)

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3D PRINTED POLYMER STRUCTURES FOR SPACE APPLICATIONS

Abstract

The escalating demand for agility, speed, and cost-efficiency in the space sector has catalyzed the exploration of cutting-edge manufacturing technologies and materials. This study, a collaboration between Prusa Polymers and TRL Space, scrutinizes the viability of 3D-printed polymer materials for space applications, challenging the traditional skepticism surrounding polymer use in space. This research is particularly groundbreaking due to the introduction of a novel dissipative polymer that has successfully undergone comprehensive outgassing testing, showcasing its potential for space missions.

Focusing on satellite structure manufacturing, the research employs a 1U CubeSat model to validate the material and 3D printing process. It aims to ensure these materials can withstand the harsh space environment, encompassing vacuum, thermal cycling, radiation, and mechanical stresses from launch to in-orbit operations. One of the aims of the material development is printability on desktop printers to reduce manufacturing cost and increase availability to broader audience.

The investigation led to the creation of four conceptual 1U CubeSat designs to assess printability, assembly techniques, and structural mass. Despite the structural mass of these designs being on par or slightly heavier than commercial counterparts, the study emphasizes the scope for optimization, particularly in infill design which is yet to be explored due to complexities like ESD property variations and vacuum-induced air release.

Structural analysis confirmed the designs' safety margins against expected loads, validating the feasibility of both hybrid (aluminum-polymer) and full-polymer configurations. While some designs showed less structural stiffness, the conservative analysis approach suggests that real-world applications, reinforced with additional components like solar arrays, could improve structural integrity.

This research positions the newly developed dissipative polymer, with its proven outgassing resilience, as a promising material for the space industry. It opens avenues for further optimization and underscores the need for ongoing investigation into 3D-printed polymers for space applications. The findings not only highlight the material's viability but also its potential to revolutionize space exploration and satellite technology, marking a significant step forward in the use of 3D-printed materials in space missions.