Paper ID: 38527
student

45th STUDENT CONFERENCE (E2)
Educational Pico and Nano Satellites (4)

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MECHANICAL FEASIBILITY OF ADDITIVE MANUFACTURING PLASTICS AS CUBESAT FRAME MATERIAL

Abstract

The CubeSat platform has successfully increased the accessibility to space for many resource-constrained research teams. In comparison to traditional satellites, the CubeSat benefits from shorter design and manufacturing times and lower development costs. To drive costs down even further for CubeSats and subsequently further increasing space accessibility, different methods of design and production can be explored that can overcome existing development challenges. One method, in particular, is the use of additive manufacturing (AM) practices.

AM creates objects by adding material layer by layer, in contrast to traditional manufacturing processes that remove material. This technological phenomenon has recently seen a growth in low-volume rapid production, enabling the creation of unique and functional artefacts. If CubeSats were to utilise such manufacturing methods, it would benefit from advantages including part consolidation and lower material usage, leading to lower costs.

This paper investigates the application of AM concepts to one particular area of a CubeSat, through the materials testing and preliminary design of a generic 1U CubeSat frame. A small sample of AM-compatible plastics was chosen to undergo thermal vacuum bakeout, uniaxial tensile testing and surface roughness testing to determine their mechanical properties and their qualification for space use. The engineering design process was used to design a generic 1U CubeSat frame concept, with the results from testing used to aid in the process. Structural analysis and cost considerations were performed, and appropriate AM machine design guidelines were adhered to during the design.

The main purpose of this work is to demonstrate to the CubeSat community a possible application of AM. Already demonstrating success in creating end-use parts for the aerospace industry and with the current shift in manufacturing paradigm towards mass customisation, CubeSats can become the forerunner for the AM of more complex and larger spacecraft. Additionally, it provides insight on how to design for AM and guidelines relevant for the CubeSat.