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ADDITIVE MANUFACTURING IN LOW EARTH ORBIT WITHIN A 1U CUBE SATELLITE

Abstract

Three-Dimensional printing in space is one of the most promising technologies advancing current capabilities for in orbit space manufacturing and assembly. Additive Manufacturing contributes to the reduction of cost of per kilogram and number of launches required to assemble space structures, while facilitating colonization and deep space exploration. The current state of the art indicates advancing efforts inside the International Space Station (ISS). However, the ISS is a controlled environment, and to the best of our knowledge, no spacecraft or satellite has performed additive manufacturing tasks in the extreme environment of outer space. In this work, a 1U cube satellite, nicknamed Orbital Factory II (OFII) will perform a technological demonstration featuring a 1-D printing, 2-DOF gantry table mechanism that will deposit conductive ink and simulate repairing of a solar cell. The material to print was selected based on bulk resistivity, viscosity, number of conductive particles, as well as curing time and low outgassing characteristics. Vacuum tests have determined the ink will cure and become conductive 20 seconds after dispensing in Lower Earth Orbit (LEO). A CMOS camera and conductivity measurements will determine mission success. Leveraging the world-class additive manufacturing capabilities of the W.M. Keck Center for 3D Innovation at UTEP, a number of satellite parts in OFII have been manufactured using ProtoTherm^{TM} 12120. ProtoTherm^{TM} is a liquid photopolymer that produces high-temperature tolerant and liquid resistant parts by Stereolithography (SLA) manufacturing process. As a secondary payload, OFII includes an experimental, additively manufactured S-band patch antenna designed and built by Lockheed Martin Space Systems. Voltage Standing Wave Ratio (VSWR) and beam pattern tests, indicate necessitating the need for attitude control via onboard active magnetorquers. OFII will be launched on a Northrop Grumman Antares rocket scheduled for October 2019 and deployed from the CRS2 NG-12 (Cygnus) spacecraft December 2019. Vibration tests based on the Antares profile and 10^{-6} torr vacuum chamber exposure reveal that our payload will withstand the lunch environment and operate in the vacuum of space. The full paper and oral presentation will discuss the design, integration, test paradigms and results performed as part of the OFII mission.