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16th IAA SYMPOSIUM ON BUILDING BLOCKS FOR FUTURE SPACE EXPLORATION AND DEVELOPMENT (D3)
Interactive Presentations - 16th IAA SYMPOSIUM ON BUILDING BLOCKS FOR FUTURE SPACE EXPLORATION AND DEVELOPMENT (IP)

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FUSED FILAMENT FABRICATION OF POLYCARBONATE COMPONENTS IN A SIMULATED ON-ORBIT ENVIRONMENT

Abstract

This study aimed to investigate the use of Fused Filament Fabrication (FFF) to fabricate structural components from polycarbonate in an on-orbit environment by placing an FFF printer in a simulated on-orbit environment and fabricating test components. These components were studied to determine dimensional accuracy of the FFF process and the mechanical properties of polycarbonate fabricated using FFF in the simulated on-orbit environment. FFF in an on-orbit environment could be used for maintenance and repair of satellites or to manufacture entire space systems. Manufacturing on-orbit reduces launch requirements as raw material can be packaged very efficiently and components do not need to be designed to withstand the forces of launch.

The simulated on-orbit environment was chosen to be a vacuum environment of 1000 Pa. Other characteristics of an on-orbit environment such as microgravity and radiation were not considered due to equipment limitations. Components were fabricated using a commercial FFF printer in the vacuum environment, beginning with simple geometries to evaluate printer and process functionality. Once it was established that the FFF process could be carried out in the vacuum environment, several test components were fabricated for mechanical testing. These test components were evaluated for dimensional accuracy and mass and were qualitatively analyzed by eye and using an optical microscope. Following this analysis, tensile, compressive and flexural tests will be carried out according to ASTM standards.

It was found that that the FFF process can be successfully carried out in a vacuum environment. The printhead could be accurately positioned, the heaters functioned properly and filament was correctly extruded with minimal modifications required. Unexpected clogging of the nozzle was observed in the vacuum environment, likely due to premature softening of the filament caused by inadequate cooling. This was addressed by replacing the nozzle with one which better isolated the filament from the heated nozzle. Test components with small cross-sectional areas had very poor quality, likely due to printing on soft preceding layers caused by the lack of convective cooling in vacuum. The results of the mechanical testing were not available at the time of writing this abstract.

In conclusion it was found to be possible to use the FFF process in a vacuum environment to fabricate dimensionally accurate polycarbonate components with a variety of geometries. While there are several issues with thermal control, it is expected that these issues can be solved with currently available technology.