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Microgravity Experiments from Sub-Orbital to Orbital Platforms (3)

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MANUFACTURING FIBER-REINFORCED COMPOSITES IN MICROGRAVITY

Abstract

Current research includes the production of fiber-reinforced composites through additive manufacturing. Additively manufactured fiber-reinforced composites are advantageous materials in terms of specific tensile strength and versatility. This makes them highly requested in the aerospace sector. Recent research suggests the possibility of in-space manufacturing as a viable alternative to traditional space structures. This work investigates the feasibility of fabricating fiber-reinforced composites in a microgravitational environment. A REXUS sounding rocket is utilised to achieve a microgravity environment for a duration of 2.5 minutes. Therefore, an automated mechanism is developed and tested. This automation enables the variation of different parameters such as extrusion speed throughout the fabrication process. The mechanism co-extrudes a thermoplastic matrix with a continuous fiber to produce a fiber-reinforced composite. A continuous fiber-reinforced specimen is produced by a self-developed, fully automated 3D-printer that is optimized to work in an artificially pressurized rocket-module with 1 atm. Thermoplastic filament such as PLA, PETG and PEEK, is stored in a bowden tube and, together with the fiber, fed to the hotend by a dual gear bowden extruder. After impregnation, the composite is cooled down and stored on a spool driven by a stepper motor. The experiment is autonomously driven by an STM32 and a Raspberry Pi Zero. Through an interface to the service module of the REXUS vehicle, data and communication are

provided. This experiment provides knowledge on the behavior of in-space manufacturing of reinforced plastics and increases the technology readiness level (TRL) of the fabrication process.