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

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FLIGHT RESULTS OF AN EXPERIMENTAL MOONFIBRE SPINNING APPARATUS ONBOARD A REXUS SOUNDING ROCKET

Abstract

Within the context of returning humans to the Moon, various entities aim to mine lunar resources,

perform scientific experiments, and build orbital and surface stations. Building lunar bases using only Earth-sourced materials is too expensive. The common approach to solve this problem is the In-Situ Resource Utilization. By utilizing local resources, different products can be created and put in service directly on the Moon. The MoonFibre project of RWTH Aachen University develops a novel type of such materials that are based on fibres. Current MoonFibre are produced using conventional spinning apparatus and lunar simulant. While these are similar in composition to terrestrial basalt fibres, MoonFibre will be produced entirely of lunar regolith on the Moon surface. MoonFibre-based products can then be utilized as structural reinforcement, hydroponic substrates or thermal insulation, thus contributing to a sustainable and affordable lunar settlement. Terrestrial basalt-fibre spinning process is well developed. However, spinning of continuous basalt fibres in space environment has never been attempted before. This paper presents design and final experimental results of IMFEX, a project within broader MoonFibre context, aiming to demonstrate technical feasibility of spinning fibre material made of lunar regolith simulant in microgravity conditions. The experiment is to be launched in March 2022 on a REXUS sounding rocket, providing three minutes of experiment time in microgravity conditions. During this time, spinning of MoonFibre will be attempted in space environment for the first time. The experiment fits in a module 356 mm in diameter and 220 mm in height, demonstrating that miniature spinning apparatus can be developed for use on the Moon in future. Unlike terrestrial facilities that rely on gravity for the spinning process, this experimental design uses centrifugal forces to push the melt through two nozzles placed opposite of each other by rotating the oven, placed inside a pressure vessel. The oven will be preheated while the REXUS rocket is on the launch pad and the required temperature will be held during powered flight. Once microgravity conditions are reached, the oven will rotate for 3 minutes, spinning about 1.4km of basalt fibre. Upon recovery, crystalline structure and mechanical properties of spun fibres will be analysed and compared to conventionally spun reference specimen of same mineralogical composition. This experiment, designed entirely by a team of students, serves as a proof of concept, and will provide vital insight of how gravity influences the spinning process and mechanical properties of MoonFibre.