48th STUDENT CONFERENCE (E2)
Student Team Competition (3-GTS.4)

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CRITICAL DESIGN OF THE MOONFIBRE EXPERIMENTAL APPARATUS FOR THE USE ON A REXUS SOUNDING ROCKET

Abstract

Space industry shows new interest to return to the Moon in this decade. Different 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 various products can be created and put in service directly on the Moon. One type of such materials are fibre-based, developed within the MoonFibre project of RWTH Aachen University. 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, requiring only energy as additional input. 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. To this author's knowledge however, spinning of continuous basalt fibres in space environment has never been attempted before. This paper presents a final design of an experimental spinning apparatus. This apparatus is to be launched 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 inside a module 356 mm in diameter and 220 mm in height. Terrestrial spinning facilities are much larger and require extensive manpower for operation. Gravity forces the molten basalt from the oven through multiple nozzles, at which point the melt is quenched and fibres are created. Instead, this experimental design uses centrifugal forces to push the melt through two nozzles placed opposite of each other by rotating the oven. The spinning apparatus is placed inside a pressure vessel. As it leaves the nozzles, molten simulant is quenched by air pressurized at 1 bar. To prevent components from overheating, air circulates between the pressure vessel and a heat sink, where heat is stored latently using a phase change material. A camera is used to confirm successful creation of fibres already during flight, which are collected inside the experiment module and will be recovered for the post-flight analysis. 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 MoonFibre spinning process and mechanical properties.