Paper ID: 84077
student

IAF SPACE EXPLORATION SYMPOSIUM (A3)
Interactive Presentations - IAF SPACE EXPLORATION SYMPOSIUM (IP)

Author: Mr. Maxim Isachenkov
Politecnico di Milano, Italy

Mr. Raffaele Pisani
Politecnico di Milano, Italy
Prof. Antonio Mattia Grande
Politecnico di Milano, Italy
Prof. Giuseppe Sala
Politecnico di Milano, Italy

ENHANCING ADDITIVE MANUFACTURING OF LUNAR REGOLITH CERAMICS THROUGH MAGNETIC BENEFICIATION

Abstract

Lunar regolith holds significant potential as a primary resource for In-situ Fabrication and Repair during future crewed lunar exploration missions. Leveraging lunar regolith for in-situ additive manufacturing enables the rapid production of on-demand items, spare parts, instruments, and infrastructure components for lunar bases. This approach offers cost reductions in lunar base construction and maintenance while expanding resource utilization. Among the various AM techniques proposed for in-situ fabrication with lunar regolith, stereolithography-based additive manufacturing stands out as a promising method to create precise, high-density, and robust ceramic parts from lunar regolith. However, the heterogeneous mineral composition of LR presents challenges in the processability of stereolithography-based additive manufacturing, resulting in increased printing time and compromised sinterability. This research aims to investigate the influence of the preliminary beneficiation of the lunar regolith on the sintering behavior, mechanical properties, and microstructure of 3D-printed lunar regolith ceramics. Our findings demonstrate that magnetic beneficiation of lunar regolith can enhance its sintering behavior and dramatically improve printability using stereolithography-based AM. Magnetic beneficiation helps to decrease exposure for 1 layer from 60 to only 5-10s, which in turn leads to a 10-fold reduction in printing time. Consequently, this enables the efficient and rapid production of high-density, mechanically robust ceramic parts using lunar regolith feedstock. Produced parts were analyzed using optical and scanning electron microscopy, coupled with energy dispersive x-ray spectroscopy to identify the evolution of mineral phases present. Preliminary mechanical testing was conducted to determine the compressive and flexural strength of the ceramic parts manufactured from beneficiated lunar regolith.