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IN-SITU CONSTRUCTION ON MARS : 3D PRINTING AND CONVENTIONAL SINTERING OF MARS SOIL SIMULANT (JMSS-1)

Abstract

Long duration space exploration will inevitably involve permanent settlement on the surface of other planets. Several plans have been developed by the space agencies along with other commercial partners to build operational stations on Mars which will be economical and resourceful to execute further missions into Deep space. Therefore, the real integration of an advanced manufacturing technique is essentially a matter of further research to design habitable architectures utilising in-situ resources available on Mars.

Additive Manufacturing (AM) technique seems promising in recent days to develop complex structures by depositing multiple consecutive layers. In this context, Martian soil is regarded as an ideal feedstock for construction materials. The purpose of this investigation is to develop a stable Martian concrete by following a multistage processing and design highly dense product by using Microwave heating method.

Considering the challenges associated with building infrastructure on Mars, a new construction material is composed by using a recently developed artificial Mars soil called JMSS-1. In this work, a processing route has been demonstrated by involving JMSS-1 to produce slurry that is amenable for 3D printing. Particle size distribution plays a significant role in this process. Different percentages of JMSS-1 are investigated to obtain the optimal mixing proportions. A water based slurry has been developed that has 70% solid content reducing the use of additives. The developed suspension exhibits excellent rheological properties similar to concrete cement. Solid blocks and pattern structures with various shapes and sizes are developed by using a customised free-form extrusion 3D printing. The 3D printed samples exhibit very high green strength when dried in open air. The slurry is also utlized by slip casting techniques to develop various components. The samples are sintered at up-to 1200-degree Celsius using microwave (MW) heating process and high density observed through SEM microstructure. The dielectric properties of 3D printed and sintered samples are also assessed under 8 to 12 GHz frequency.