Paper ID: 72700
student

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

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EXPERIMENTAL INVESTIGATION OF LUNAR REGOLITH SIMULANTS MIXING OTHER MATERIALS IN SELECTIVE LASER PROCESSING

Abstract

Due to the extremely high cost of transport from the Earth to the Moon which is around US$ 130k per kilogram (Duke et al., 2003), in-situ resource utilization (ISRU) is the key for making sustainable lunar economy. There are about five main technologies for sintered or melted regolith (SoMR) method as following: Additive manufacturing (AM), Radiant furnace sintering, microwave furnace sintering, regolith glass and cast regolith, Regolith fiber. Many of earlier studies proves that the cast regolith technology satisfied the criteria of product strength, energy efficiency, production speed and quantity and accuracy (Farries et al., 2021). In fact, the cast technologies have been used and well proved in the manufacturing of industry and construction of building field on earth more than 100 years, but on the contrary, AM technology is a new technology compared to others. Laser processing (sintering or melting) is widely used today for ceramics by powder bed fusion methods (PBF) for acerate small part fabrication. This method is so called selective laser sintering (SLS) / melting (SLM). On earth, different materials are mixed to improve the properties ceramic materials.

Laser sintering or melting with lunar soil, called regolith, has several disadvantages, for instance, weak strength, high porosity, maximum dimension size, high energy consumption regarding its efficiency, etc., according to existing several studies. However, there is advantages of dimensional accuracy, capacity to fabricate varying shape without mold, relatively small volume of equipment. Therefore, this paper investigates, first of all, a brief review of pros and cons of existing SoMR studies of AM(laser and solar), furnace sintering, cast regolith. Second, in order to improve the strength of laser sintered product's properties and decrease the porosity of the product, several experiments of regolith mixing with different material is conducted. Due to the short period of time of research and research condition, these experiments are tested in terrestrial environment. It will however test in vacuum chamber in the future at the International Space University when the equipment is ready to use. After the experiments of laser melting in terrestrial environment, data of micro-structure and strength of sintered products are analyzed and compared for results. This research allows to find out a suitable composition of materials for selective laser melting and for future application on the lunar surface.