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Investigation on layer-wise powder deposition and sintering of regolith

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Abstract

Constructing an extraterrestrial outpost remains as one of the most challenging steps for human colonization in space [1]. Several space agencies are planning to develop a lunar habitat capable to master Additive Manufacturing (AM) for construction purposes. Based on this, In-Situ Resources Utilization (ISRU), reduces the involved cost of launching material from the Earth, approximately 5,000-10,000 €/kg [2]. Furthermore, manufacturing in a lunar gravity environment would not only affect the manufacturing process parameters, but also change the mechanical integrity of the constructions in which the structural dead loads will be reduced by 5/6 compared to the one on Earth [2-4]. Towards this issue, increased knowledge about the powder deposition in a layer-wise manner will potentially improve the efficiency of the powder based AM final products. With respect to this, layer lamination quality, layer's packing density following with layer-wise sintering of regolith simulant are investigated in this study.

Objectives

This study targets powder deposition analysis for AM applications under lunar gravity condition. The aim is to develop a multi-setting prototype capable of layer-wise compaction of the powder and to measure the saturation point regarding the powder bed density for variety of particle sizes and distributions. JSC-2A has been applied as the test lunar simulant in this study. An illustration of the developed prototype is shown in Figure 1. the setup consists a rotating arm with an integrated weight container. Powder is then deposited in a circular path atop of the building platforms which would be subsequently exposed to heat radiation.

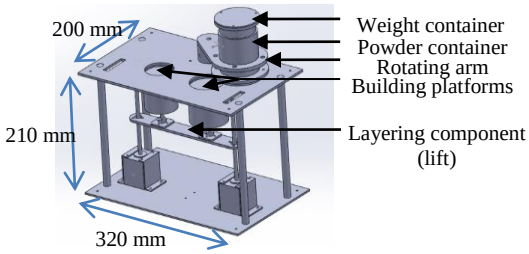

Figure 1: Isometric view of the prototype assembly for layer-wise deposition study.

Furthermore, the lamination quality of the powder using different coating speeds, temperatures, layer thickness as well as the grain size distribution have been investigated in this study. This was followed by layer-wise sintering of the power using the investigated optimum process parameters. Fabricated samples were studied regarding their morphology, thermal and mechanical properties. Different components of the developed layer deposition setup are shown in Figure 2.

Figure 2: Layer-wise sintering of the JSC-2A

Outlook

The layer-wise powder deposition will be conducted under lunar gravity during a parabolic flight and the results will be compared to the obtained one on earth. The setup process parameters will consequently be adjusted in order to duplicate the lunar gravitational fabrication results.

References

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