Utilization of lunar regolith for extraterrestrial construction based on additive manufacturing

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Renewed interest in space exploration has led space agencies to address the need of investigating strategic solutions to the realization of future permanent settlements on the Moon. The construction of buildings and infrastructures on the Moon requires environmentally and economically sustainable approaches based on the principle of *in situ resource utilization* (ISRU), which envisages the exploitation of raw materials available on the Moon. Based on this principle, the research investigates the possibility of formulating cementitious binders based on the chemical activation of lunar regoliths by means of alkaline solutions. The implementation of this approach requires that the formulated binders meet some specific criteria for construction in lunar environment, namely: a) limited availability of workforce; b) resistance to freeze-thaw cycles, due to extreme temperature variations; c) adaptability in reduced gravity environment. To meet the first criterion, the research envisages a digital construction process based on additive manufacturing (3D printing), which in turn necessitates of specific rheological properties of the alkali-activated regoliths. The other two criteria are addressed by devising a dedicated procedure for the foaming of the regolith binder, which will provide optimal thermal properties, and allow the 3D-printed structures to withstand extreme temperature variations. The properties of the foamed binder will be optimized to ensure foam stability in reduced gravity environment. In the final phase of the project, the mechanical properties of the consolidated foams will be assessed and reconciled with the small-scale processes leading to microstructural development during the reaction between regolith and alkaline solutions.
The successful implementation of this research may likely inspire virtuous approaches to the use of local resources for sustainable construction back on planet Earth.

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