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INTEGRATED APPROACH FOR WATER PRODUCTION AND ADDITIVE MANUFACTURING USING MAGNETICALLY-BENEFICIATED LUNAR REGOLITH

Abstract

Utilization of the lunar regolith is going to have a central role in supporting the exploration of the lunar surface. Numerous technologies are under study these years to exploit the uppermost layer of the lunar surface, among which the extraction of oxygen and water from minerals and additive manufacturing have a pivotal role. At Politecnico di Milano, ongoing research and demonstration efforts are directed towards the low temperature carbothermal reduction of lunar surface material, employing a two-step process involving carbothermal and methanation reactions. This approach aims to extract water from lunar minerals, demonstrating versatility by accommodating a wide range of possible regolith feedstock compositions. Nevertheless, the optimization of process yield and water production warrants strategic selection of specific minerals. The lunar highlands regolith is composed of iron-rich basalts and iron-poor anorthosite, which may be separated in the dedicated magnetic beneficiation stage with the help of an electromagnet. It was shown that after separation these two fractions can be used more efficiently than the non-refined genuine feedstock. While the iron-rich basalt is not well suited for the stereolithography-based 3d-printing due to its high absorption in UV-range, it yields the higher oxygen production rate during carbothermal process, thanks to the lower oxygen's bonding energy. On the other hand, it was found that iron-poor anorthosite fraction is a perfect feedstock for ceramic manufacturing via stereolithography-based AM, due to its lower UV-absorption and higher melting temperature. Thereby, it was experimentally shown that introduction of preliminary magnetic beneficiation of lunar regolith may contribute to increasing the oxygen production rate and improving the printability of the regoloth via stereolithography-based AM, showcasing a holistic and integrated approach to lunar regolith utilization.