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CONCEPTUAL DESIGN FOR AN IN-SITU LUNAR REGOLITH REFINEMENT PROCESS.

Abstract

In-situ resource utilization (ISRU) represents a pivotal field for the future of human space exploration. Celestial bodies, such as the Moon, are rich in material resources that not only present a substantial potential for profit, but are also critical for the development of human habitats. This work presents a conceptual design for a lab-scale (1-kg reactant mass) device to simulate in-situ lunar regolith refinement process. The proposed process utilizes triboelectric static beneficiation technology, a microwave pre-bake and melting system, and a direct molten regolith electrolysis reactor for the reduction of oxides. Additionally, a solute-rejection based purification regime to produce high-purity silicon for photovoltaic applications is included. In the long term, this system will be capable of producing useful materials for habitat and power infrastructure, breathable air, and fuel from the most common lunar regolith constituents. MatLab simulations were used to evaluate and predict the energy requirements and thermal operating conditions. Finally, a scale analysis is presented to demonstrate the future capacity and scalability of this process.