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IN-SITU RESOURCE UTILIZATION FOR EXTRATERRESTRIAL ARCHITECTURE: A COMPREHENSIVE APPROACH TO REGOLITH PROCUREMENT, PROCESSING, AND 3D PRINTING IN MARTIAN ENVIRONMENTS

Abstract

In the pursuit of establishing sustainable colonies on the lunar and Martian surfaces, this paper proposes an innovative approach utilizing In-Situ Resource Utilization (ISRU), with a specific focus on the Martian regolith for composite manufactured that can be used for the further 3D printable structures for human settlement. The Martian regolith, abundant in construction potential, presents a unique challenge due to its high iron content. Our two-step solution involves magnetic separation to selectively remove iron, enhancing the material's suitability for construction, followed by microwave sintering that efficiently fuses the refined particles into a consolidated mass, aligning with the Martian regolith's composition. This approach, grounded in the utilization of locally-sourced resources, particularly the BASALT derived from Martian regolith, addresses the challenges posed by the regolith's high iron content. BASALT, an acronym for "Bulk Alkali-Silica of Aluminum and Ferric Iron Oxide from Silicate Source," is a key component with advantageous properties, including abundance, favorable chemical composition, thermal resilience, processing suitability, and the ability to tailor its properties. Leveraging these aspects, BASALT becomes a foundational material for constructing robust and durable habitats on Mars, offering a sustainable solution that minimizes the need for transporting construction materials from Earth. This research delves into the technical intricacies of ISRU techniques, contributing valuable insights to the evolving landscape of extraterrestrial colonization. As humanity embarks on interplanetary exploration, mastering regolith engineering emerges as pivotal for constructing livable structures on Mars, paving the way for a self-sustaining future in space. The proposed approach not only addresses the challenges of Mars construction but also emphasizes the importance of utilizing indigenous resources, such as BASALT, as a key step towards achieving sustainability and resilience in human settlements beyond Earth.