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MANUFACTURING AND CHARACTERIZATION OF LUNAR REGOLITH SIMULANTS

Abstract

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Abstract The UAE space program is a symbol of inspiration, hope, and national pride. In addition to being a catalyst for economic growth by creating a space industry, the program will also reinforce national security capabilities and contribute to the advancement of science, technology, and civilization. Lunar missions have been viewed as a stepping stone toward the exploration of outer space. Under this consideration, lunar regolith simulants will be instrumental for the demonstration and validation of technologies in the design process, thus increasing the chance of success during the actual mission. Yet, the availability of the simulants is very limited, while the cost could be prohibitive for large-scale demonstration. The main purpose of the proposed research is thus to utilize locally available materials to produce simulants of similar physical, chemical, mineral/micromechanical properties to the actual lunar regolith. Design requirements will be first identified. Utilization of an existing simulant was first implemented to serve as a learning curve and to build up the capability for analyses of the actual regolith samples which are extremely difficult to acquire due to their scarcity. It is postulated that many of the design parameters could not be fully met with available local resources. To overcome this, a performance-based design approach will be implemented where unfulfilled design requirements are substituted by other parameters to obtain the intended performance. A series of investigation techniques, including particle size analysis, scanning electron microscopy (SEM), X-ray diffraction (XRD), X-ray fluorescence (XRF), and nano-indentation, was performed on the simulant. Meanwhile, high-resolution microscopy and spectral imaging of the material were also assessed with computer vision and machine learning for automatic quantification of the physical and mineral composition. The knowledge gained will aid data analysis for future rover missions. Properties of potential local deposits will then be quantified. Based on their properties and the design requirements, processing, proportioning, and optimization of the selected deposits will be performed in the next stage of the study. Grinding with both planetary ball mill and high pressure grinding rolls to produce particles of different shapes and sizes will be conducted. Engineering properties will finally be evaluated for the simulants before their applications for technology demonstration and validation.