20th IAA SYMPOSIUM ON BUILDING BLOCKS FOR FUTURE SPACE EXPLORATION AND DEVELOPMENT (D3)
Interactive Presentations - 20th IAA SYMPOSIUM ON BUILDING BLOCKS FOR FUTURE SPACE EXPLORATION AND DEVELOPMENT (IPB)

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AN EVALUATION OF LUNAR REGOLITH SIMULANTS

Abstract

Purpose: Returning humans to the surface of the Moon will require development of innovative technologies in many areas, including but not limited to construction of habitats, mobility, in situ resource utilization, and power generation. A critical aspect of development and maturation of technology is testing under relevant lunar surface conditions, including in the presence of and utilizing lunar regolith simulants. Since simulants are approximations of lunar regolith, they do not reproduce all of the characteristics that lunar regolith exhibits on the Moon.

Methods: Simulants from four providers (Exolith, Off Planet Research, Colorado School of Mines, and Outward Technology) were evaluated in terms of particle size distribution (PSD), particle shape, and composition. Samples were sieved into 6 particle size fractions, which were weighed to establish a rough PSD. In addition, simulants were evaluated using the Camsizer X2 instrument, providing aspect ratios and PSD from 0-1000 m (3 m bins). We examined polished epoxy mounts of the 125-250 m particle size fraction using a Hitatchi TM 3000 tabletop Scanning Electron Microscope (SEM), producing elemental maps with the associated Bruker Q70+ silicon drift detector energy dispersive spectrometer (EDS) system. Finally, we examined bulk simulants using X-ray Fluorescence (XRF) to derive bulk elemental composition and X-ray Diffraction (XRD) to determine the number and rough amounts of crystalline mineral phases present in the sample.

Results: All simulants exhibit a PSD within one standard deviation of an average Apollo regolith, although simulants contain a greater abundance of larger grains and have a steeper slope to their PSD curve. Particle shapes of all lunar regolith simulants are more rounded than lunar regolith grains. There is a fairly good match for bulk composition to lunar regolith, however all simulants contain higher sodium (due to the sodium-rich nature of terrestrial plagioclase), higher titanium and lower magnesium than measured in lunar regolith. Finally, mafic materials are often glassy, so simulants may be a poor match to the mineralogy and glass found in lunar regolith.

Conclusions: The suitability of a simulant is specific to its application and all users should carefully consider the needs of their application when selecting a regolith simulant. Simulants from current simulant providers should meet the needs of most users and most providers have the willingness and capability

to adapt their product to the users need given sufficient lead time. We recommend consulting a lunar geologist or regolith expert when selecting the appropriate simulant.