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Infrared Spectrometry and Thermal Radiative Properties of Lunar Dust Simulants

Aravintha Raj Ravichandran
University of North Texas

Vanessa Bristow
University of North Texas

Joohyun Seo
University of North Texas

Richard Zhang
University of North Texas

Abstract

Infrared spectrometry of lunar dust simulants can provide understanding of the Moon's surface thermal signatures, detection of composition variations, and identifying possible presence of water for future explorations. We perform Fourier transform infrared spectrometry (FTIR) of four lunar regolith simulants under various environmental testing conditions. The Moon's soil or regolith is composed of fine dust particles of mostly silica, alumina, and lime, with variations between lighter Highlands (Artemis) regions and darker Mares (Apollo) valleys. The Artemis and Mares dust simulant blends and their extra-fine blends are measured in FTIR diffuse reflectance after humid and ambient baking preparations. The simulants were imaged in scanning electron microscope to validate the particle size distributions, where the extra-fine mix is composed of particles mostly smaller than 4 um. The impact of particle size presents differences in the reflectance spectra, with finer particles exhibiting average reflectance above 0.25 and coarse particle mixtures exhibiting wide variations in reflectance up to 0.35 for the brighter Artemis sample. A Bruggeman effective medium model for small particles validates differences in Highlands and Mares types in the far-infrared. The room temperature blackbody integrated thermal emittance of coarse dust samples was calculated to 0.78, while the extra-fine compositions are 0.67. The reflectance variation and emittance reduction are due to particle packing and less scattering from particles greater than few microns. This work motivates particle size filtering for lunar regolith sensing, processing, and manufacturing.