FAR-ULTRAVIOLET PHOTOMETRIC RESPONSE OF SIEVED JSC-1A LUNAR SOIL SIMULANT.
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Introduction: Previous far-ultraviolet (FUV) reflectance studies of Apollo soil 10084 have shown this mare soil to be an anisotropic backscatterer [1]. In this study, we characterize the FUV photometric response of lunar simulant JSC-1A. Although similar to lunar soil in its chemical composition, JSC-1A lacks the agglutinates and nanophase iron associated with space weathering [2]. In contrast to the Apollo 10084 sample, sieved JSC-1A samples consistently show forward scattering of FUV light.

Experimental Methods: This investigation utilizes the Southwest Ultraviolet Reflectance Chamber (SwURC), an ultra-high vacuum chamber with FUV instrumentation for bidirectional reflectance measurements of soil and volatile samples [3]. FUV light is provided by a 30-watt deuterium lamp, with wavelengths selected via a grating monochromator. The source is fixed at 45° with respect to the sample tray normal. Within the chamber, a channeltron detector (Photonis 5901 Spiraltron, CsI-coated) is mounted on a rotating armature, which is used to measure the bidirectional reflectance along the principal plane. More details on the SwURC instrumentation can be found in Ref [1].

The JSC-1A simulant from Orbital Technology Corporation was sieved into several grain-size categories: < 38 μm, 45-53 μm, 75-106 μm, and > 150 μm. The samples are assembled onto an Al tray as shown in Figure 1. Flattened vs. corrugated surface textures are also compared for identical grain-size samples.

Sample reflectance is characterized by the bi-directional reflectance distribution function (BRDF) as follows,

$$f_{BRDF}(\theta_r) = \frac{P_r(\theta_r)}{[P_i \cos(-45°)]\Omega_d}$$

where $P_r(\theta_r)$ is the reflected intensity as a function of reflectance angle, P_i is the raw incident intensity, the cosine factor is a correction for the larger illuminated surface area caused by the 45° inclination of the source, and Ω_d is the projected solid angle subtended by the detector. Here, $f_{BRDF}(\theta_r)$ has units of sr^{-1}. The sample reflectance is measured at 121.6 nm (Lyman-alpha), 125 nm, 130 nm, 135 nm, 140 nm, 150 nm and 160 nm with ~ 0.5 nm spectral widths. Each phase angle measurement set sweeps the detector over θ_r of -70° to 90° emission angle relative to the surface normal (or equivalently 0° to 135° phase angle). P_i for each wavelength is measured in direct line of sight position with the source with the sample tray retracted.

Figure 1: Image of > 150 μm JSC-1A (left) and < 38 μm JSC-1A (right) in the sample tray. The scale major divi-

sions are in centimeters. Note the great contrast in texture and color shade.

Results: The forward scattering properties of JSC-1A are evident in the BRDF plots for the > 150 μm and < 38 μm grain-size bin at three different wavelengths. The BRDF function for both samples show a distinct increase above 80° phase (Figure 2).

Figure 2a.

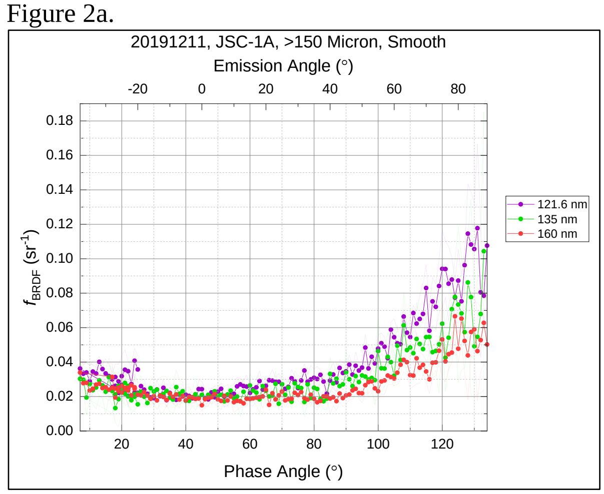

Figure 2b.

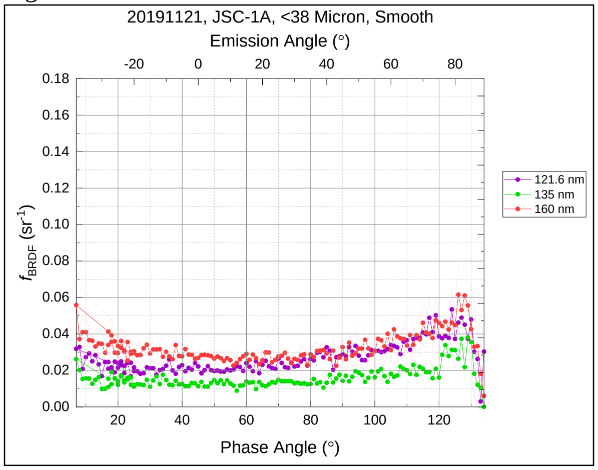

Figure 2: Plots of f_{BRDF} versus phase angle for > 150 µm JSC-1A (2a) and < 38 µm (2b). Both plots are for flattened-texture samples.

We show the 160 nm (red), 135 nm (green) and the 121.6 nm (purple) of the seven wavelengths for clarity of presentation.

We note preliminarily that the larger JSC-1A grains (> 150 um) show stronger forward scattering than the finer < 38 µm grains; however, additional measurements are needed to confirm this dependence. Further studies of lunar soil with different maturity are planned to investigate the possible role of nanophase Fe and agglutinates in scattering of FUV light.

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References: [1] Raut et al., (2018), Far-ultraviolet photometric response of Apollo Soil 10084, *Journal of Geophysical Research: Planets*, *123*, 1221-1229. [2] Taylor et al., (2016) Evaluations of lunar regolith simulants, *Planetary and Space Science*, *126*, 1-7. [3] Karnes et al., (2013) Radiometric calibration of the SwRI ultraviolet reflectance chamber (SwURC) far ultraviolet reflectometer, SPIE, 8859.