The Bidirectional reflectance distribution function (BRDF) and 8° directional/hemispherical reflectance data of JSC Mars - 1 Regolith Simulant are intended to more completely describe its characteristics.

The BRDF and hemispherical data are given for a spectral range from 250 to 900 nm, and scatter angles from -60° to 60° in 10° steps.

The hemispherical and diffuse scatter data obtained from these studies are important for future Mars space and ground based observations through analysis of its diffuse reflectance properties.

The measurements were done in a clean room calibration facility and the results are NIST traceable.

**BACKGROUND**

The scatterometer of the National Aeronautics and Space Administration’s Goddard Space Flight Center (NASA’s GSFC) Diffuse Calibration Facility (DCaF) was used for the measurements reported. The data were obtained with a monochromator-based light source in the UV, VIS, and NIR spectral regions. The BRDF measurements were performed at different angles of incidence, and over a range of in-plane and out-of-plane geometries.

The BRDF is usually referred to as the ratio of the scattered radiant \( I_s \) scattered by a surface into the direction \((\theta_i, \phi_i)\) to the collimated irradiance \( I_i \) incident on a unit area of the surface:

\[
BRDF = \frac{I_s(\theta_i, \phi_i, \theta_s, \phi_s, \lambda)}{I_i(\theta_i, \phi_i, \lambda)}
\]

where \( \theta \) is the polar angle, \( \phi \) is the azimuthal angle, the subscripts i and s are for the incident and scattered directions respectively, and \( \lambda \) is the wavelength.

In practice, we usually present BRDF in terms of the incident power, scattered power and the geometry of the reflected scatter. It is equal to the scattered power per unit solid angle normalized by the incident power and the cosine of the detector view angle:

\[
BRDF = \frac{P_s}{P_i \cos \theta_i}
\]

where \( P_s \) is the scattered power, \( \Omega \) is the solid angle determined by the detector aperture, \( A_s \), and the radius from the sample to the detector, \( R \), or \( \Omega = A_s/R^2 \), \( P_i \) is the incident power, and \( \theta_i \) is the scatter angle.

**EXPERIMENTAL**

- in- and out-of-plane measurements
- unpolarized scatter
- angles of incidence: 0°, ±10°, 20°, ±30°, 40°, 50°, ±60° in-plane and at 0° and ±10°, out-of-plane
- scatter angles: 0°, 10°, 20°, 30°, 40°, 50°, and 60°
- spectral range in 50 nm steps from 250 to 900 nm for the 0° and ±10° in-plane and out-of-plane
- in 100 nm steps for in-plane incidence angles of 30° and 60°
- in 200 nm steps for in-plane incidence angles of 20°, 40°, 50°, ±30° and ±60°
- NIST calibrated Specotron and pressed halon samples

**BRDF at normal angle of incidence**

- 0° incidence from 250 to 900 nm in 50 nm steps
- scatter angles from -60° to 60° in 10° steps
- from 4.7x10⁻⁴ sr at 250 nm to 731x10⁻⁶ sr at 850 nm, at 10° scatter
- BRDF at 900 nm is lower, attributed to the ferric absorption band in the 800-900 nm region.
- Symmetric at all wavelengths and scatter angles

**BRDF at non-normal angles of incidence**

<table>
<thead>
<tr>
<th>Scatter angle, deg</th>
<th>BRDF, sr⁻¹</th>
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</thead>
<tbody>
<tr>
<td>-20</td>
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</tr>
<tr>
<td>0</td>
<td>0.020</td>
</tr>
<tr>
<td>10</td>
<td>0.015</td>
</tr>
<tr>
<td>20</td>
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<td>0.015</td>
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<td>40</td>
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<tr>
<td>50</td>
<td>0.015</td>
</tr>
<tr>
<td>60</td>
<td>0.020</td>
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</tbody>
</table>

**CONCLUSIONS**

- Monochromator based light source in the UV, VIS and NIR spectral regions for both BRDF and hemispherical measurements was employed
- In-plane and out-of-plane geometries were used for the BRDF measurements at a number of incident angles of incidence and over a range of scatter angles
- The experimental data show a flat BRDF response in the UV with increasing deviation from the Lambertian at higher wavelengths
- The ferric absorption feature in the 800-900 nm spectral region is evident in the BRDF versus wavelength data
- The 8° directional/hemispherical data support the spectral distribution data from the BRDF measurements
- The hemispherical and diffuse scatter data obtained from these studies are important for future Mars space and ground based observations through analysis of its diffuse reflectance properties
- The BRDF of the sample varies widely depending on angles of incidence and scatter
- The reported data were measured in clean room calibration facility and the results presented are NIST traceable from calibrated standard plates.