# LHS-1D Dust Simulant | **Fact Sheet**

*July, 2022*

**Simulant Name:** LHS-1D Dust Simulant
**Simulant Type:** Extra-fine lunar highlands simulant for dust studies
**Reference Material:** Average lunar highlands
**Uncompressed Bulk Density:** 0.70 g/cm$^3$
**Mean Particle Size:** 7 µm
**Median Particle Size:** 5 µm
**Particle Size Range:** <0.04 – 35 µm


## Geotechnical Properties

[1]**Grain Density:** 3.22 g/cm$^3$
[1]**Void Ratio:** 3.6
[1]**Porosity:** 78.26%
[2]**Avg Angle of Repose:** 46.36°
[2]**Max Angle of Repose:** 49.0°
[3]**Cohesion:** 0.205 kPa
[3]**Angle of Internal Friction:** 28.62°

## Geotechnical Property Sources

[1] 5013.PDF (usra.edu)

[2] (PDF) Comparing the Effects of Mineralogy and Particle Size Distribution on the Angle of Repose for Lunar Regolith Simulants (researchgate.net)

[3] 2038.PDF (usra.edu)

## Mineralogy

As mixed.

| Component | Wt.% |
|---|---|
| Anorthosite | 74.4 |
| Glass-rich basalt | 24.7 |
| Ilmenite | 0.4 |
| Olivine | 0.3 |
| Pyroxene | 0.2 |

## Safety

See SDS for details. Primary hazard is dust inhalation; wear a respirator in dusty conditions.

## Bulk Chemistry

Relative abundances. Measured by XRF.

| Oxide | Wt.% |
|---|---|
| $SiO_2$ | 51.2 |
| $TiO_2$ | 0.6 |
| $Al_2O_3$ | 26.6 |
| FeO | 2.7 |
| MnO | 0.1 |
| MgO | 1.6 |
| CaO | 12.8 |
| $Na_2O$ | 2.9 |
| $K_2O$ | 0.5 |
| $P_2O_5$ | 0.1 |
| LOI* | 0.4 |
| Total** | 99.4 |

* Loss on ignition
** Excluding volatiles and trace elements

Photo credit Matthew Villegas. XRF data obtained by Hamilton Analytical Lab using fused bead sample preparation. Reflectance spectrum courtesy of Dr. Takahiro Hiroi, NASA RELAB, Brown University.

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## Trace Elements

Measured by XRF

| Element | ppm |
|---|---|
| **Ni** | 26 |
| **Cr** | 54 |
| **V** | 46 |
| **Sc** | 6.2 |
| **Cu** | 14 |
| **Zn** | 29 |
| **Ga** | 19 |
| **Ba** | 265 |
| **Rb** | 9 |
| **Cs** | 0 |
| **Sr** | 349 |
| **Y** | 4 |
| **Zr** | 59 |
| **Hf** | 1.9 |
| **Nb** | 10.6 |
| **Ta** | 1 |
| **Mo** | 4 |
| **La** | 12 |
| **Ce** | 20 |
| **Nd** | 7 |
| **Sm** | 0.7 |
| **Dy** | 1.9 |
| **Yb** | 0.0 |
| **Th** | 0 |
| **U** | 1 |
| **Tl** | 0 |
| **Pb** | 4 |
| **Sn** | 3 |
| **Bi** | 0 |
| **Sb** | 1 |

## Volatiles

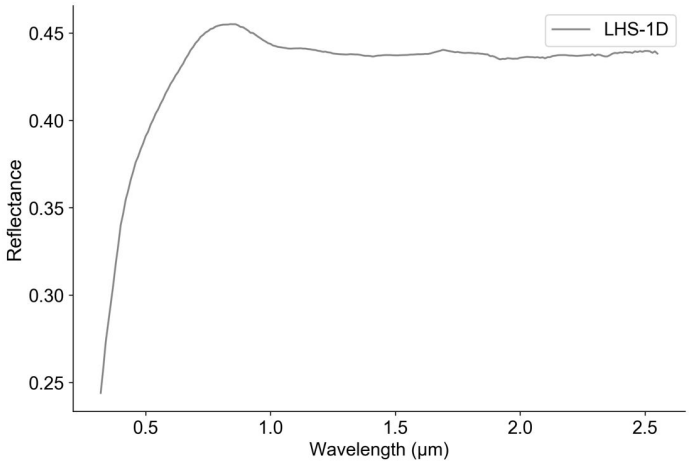
Measured by XRF

| Compound | Wt% |
|---|---|
| **F** | ≥0.07 |
| **Cl** | ≥0.006 |
| **$SO_3$** | ≥0.01 |

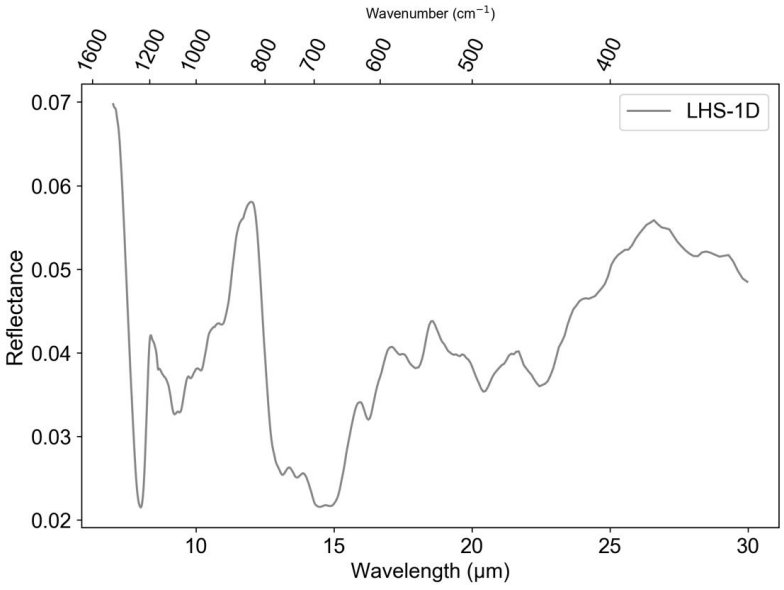
| Compound | ppm |
|---|---|
| **Br** | ≥3 |
| **As** | ≥1 |

## Reflectance Spectrum

Incidence angle 30°, emission angle 0°



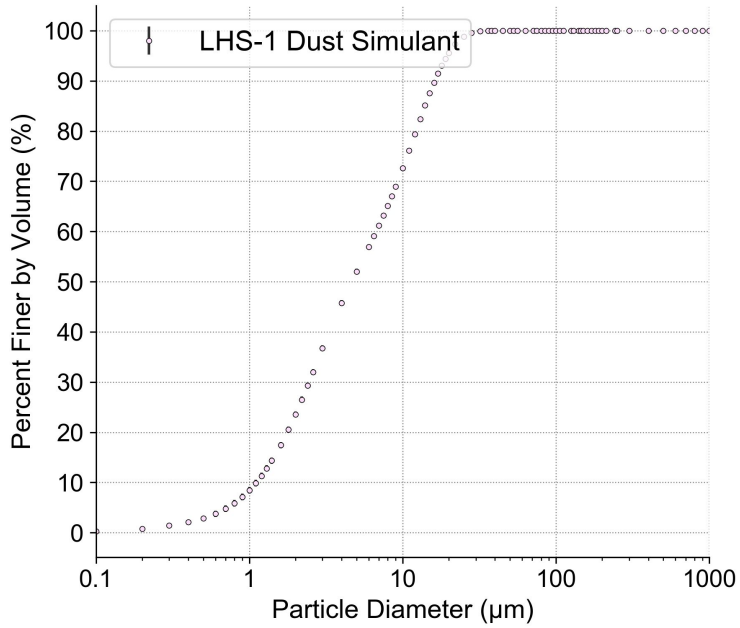

## Mid-Infrared FTIR Spectrum

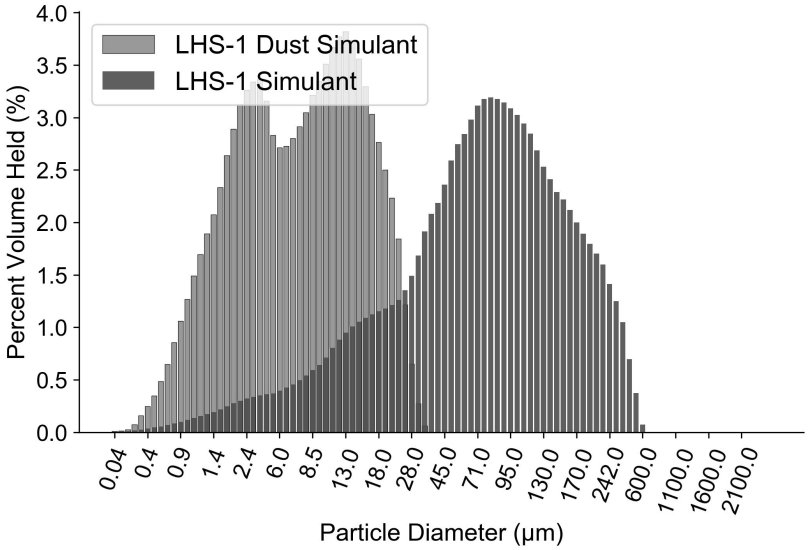



XRF data obtained by Hamilton Analytical Lab using fused bead sample preparation. FTIR spectrum courtesy of Dr. Takahiro Hiroi, NASA RELAB, Brown University.

## Particle Size Distribution

From CILAS 1190 laser diffraction particle size analyzer




| Particle Diameter | Percentage finer | Particle Diameter | Percentage finer |
|---|---|---|---|
| 1 mm | 100.0% | 25 µm | 98.8% |
| 250 µm | 100.0% | 10 µm | 72.6% |
| 125 µm | 100.0% | 5 µm | 52.0% |
| 75 µm | 100.0% | 1 µm | 8.5% |
| 45 µm | 100.0% | 40 nm | 0.1% |