



# Optothermal Properties of Extraterrestrial Dust Simulant-Doped Glazes on Ceramics



**THERMAL & FLUIDS ANALYSIS WORKSHOP**  
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## Motivation & Objectives

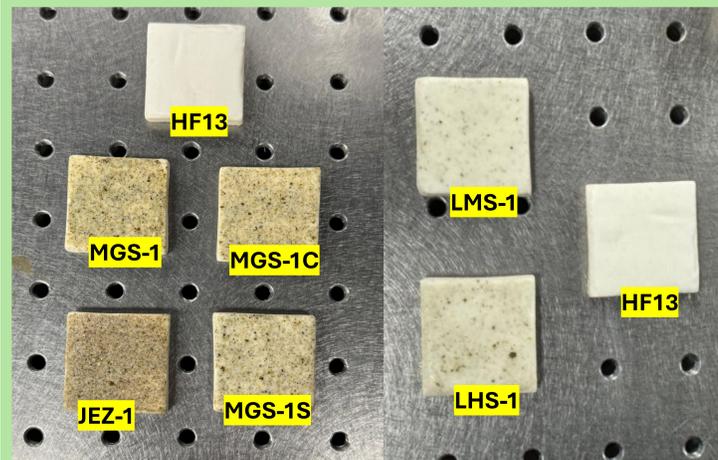
Extraterrestrial exploration yields opportunity for processing local raw materials for manufacture. Infrared emittance analysis of Lunar and Martian dust establishes an understanding of their thermal radiative characteristics, such that they can be processed into ceramic glazes for thermal protection and dust mitigation. A method of developing these glazes is presented, as well as initial phases of creating cast ceramics out of the dust samples themselves. Spectroscopic analyses were performed to observe the diffuse reflective & emissive properties of several tile samples via an integrating sphere and portable emissometer.

## Methodology

**Lunar Dust:** LMS-1 (Mare), LHS-1 (Highland)  
**Martian Dust:** MGS-1 (Global), MGS-1C (Hydrated Clay), MGS-1S (Polyhydrated Sulfate Gypsum), JEZ-1 (Jezero Delta Crater)  
Dust samples are processed as an additive to basic white glaze (HF13). **A proportion of 10 grams of dust is added to 100 grams of the glaze base, each with 3 to 5 coatings applied to 2"x2" ceramic tiles.** The tiles are fired at cone 6 (Δ6) in a Skutt kiln (~1220°C). After firing, the infrared diffuse reflectance data and solar absorptivity for each sample was acquired.



## Results: Initial Samples



Apparent change in physical properties is a result of organic materials burning away after firing, as well as ferrous components of raw dust samples oxidizing.



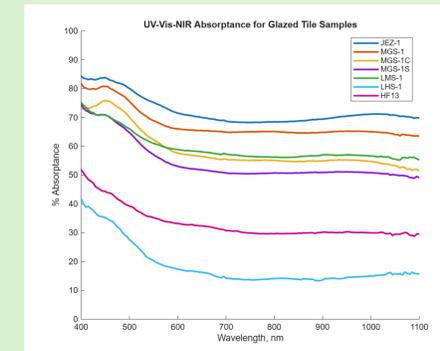
One gram of Veegum (smectite) was added to four grams of each sample and fired at cone 6 to observe the fluid flow of the raw materials. Visual inspection suggests that adding an increased amount would make the samples more plastic. In particular, the drip observed in LMS-1 compared to LHS-1 is due to the difference in mineralogy.

Sample	Ilmenite (wt.%)	Anorthosite (wt.%)
LHS-1	0	75
LMS-1	4.3	19.8

## Results: Post Processing

$$\varepsilon = \frac{1}{\sigma T^4} \int_{\lambda_1}^{\lambda_2} \varepsilon(\lambda) \Theta(\lambda, T) d\lambda \quad \alpha(\lambda) = \varepsilon(\lambda) = 1 - \rho(\lambda)$$

Sample	$\rho(\lambda)$	$\varepsilon(\lambda)$
HF13	0.112	0.888
LMS-1	0.111	0.889
LHS-1	0.110	0.890
MGS-1S	0.106	0.894
MGS-1C	0.105	0.895
MGS-1	0.110	0.890
JEZ-1	0.107	0.893



Infrared emittance changes little between samples. However, it's evident that the solar absorptivity is highly affected by the presence of different regolith. **The low absorptance by LHS-1 suggests it as the most efficient solar reflector.** JEZ-1 has potential as a high emitter when applied as a glaze

## Ongoing & Future Work

Design procedure to develop regolith ceramics for commercial and industrial use. This involves **iterative fluid-flow observation & effects of adding binders to raw materials. Ablation, torch testing, and mechanical stress analysis are still to be performed**, both on dust-doped glazes and dust slips.

Development of thermochromic materials to reduce mass and cost on aerospace vehicles and spacecrafts. These materials, also called variable emitters, change their radiative properties according to the thermal environment. Synthesis involves physical vapor deposition, followed by controlled-oxygen annealing



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