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# Emissivity and reflectance spectra of sulfide-bearing samples: new constraints for the hermean surface composition.

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## Abstract

Mercury is an extreme planet with the largest temperature excursion in the Solar System that may affect spectral properties of the surface. Evidences suggest plagioclase, pyroxene, and olivine, with lesser amounts of quartz as possible mineralogy of Mercury's surface. Furthermore, the presence of abundant sulfide in hollows has been proposed. Here, we measure the emissivity and reflectance of mixtures composed of a silicate and a sulfide component at different temperatures.

## 1. Introduction

Mercury is an extreme planet, the smallest, the closest to the Sun, and the planet with the largest temperature excursion in the Solar System, from ca. -180°C to ca. 430°C. This high temperature range may affect spectral properties of the surface.

Recently, X-ray [1], and Gamma-ray and Neutron [2] spectrometers, onboard the MESSENGER mission, concluded that the hermean surface is Mg-richer and Al, Ca and Fe-poorer than Moon and Earth and enriched in volatiles and alkalis as [3].

Petrological models were proposed to infer the possible mineralogies exposed on the surface of Mercury. Generally, hypothesized $SiO_2$ values for the hermean surface is higher than those on Moon and more similar to terrestrial values, thus suggesting evolved compositions. [4] constrained the potential mineralogy of Mercury's surface as dominated by plagioclase, pyroxene, olivine, with lesser amounts of quartz, and with compositions varying from alkali-rich komatiites to boninites. Furthermore, some peculiar mineralogical assemblages were suggested, like the presence of abundant sulfides in hollows [5].

[6] already demonstrated how Visible and Near-Infrared (VNIR) spectral properties of sulfides are modified by the heating at hermean temperatures, and how the temperature acts differently on sulfides with variable chemistry. However, a detailed literature about the spectral behavior of mixtures composed with hermean-like minerals (e.g., sulfides) under different temperature conditions still lacks.

We, thus, propose to measure both the reflectance and the emissivity of mixtures composed of a silicate and a sulfide component in the VIS-MIR (Visible-Mid Infrared) and in the TIR (Thermal Infrared) ranges at PSL (Planetary Spectroscopy Laboratory) at DLR, Berlin.

## 2. Methodology

We measured the reflectance spectra in VIS_MIR range (0.4-16 μm) and the emissivity of size-intimate mixtures of different end-members. Considering the mineralogies proposed for the surface of Mercury, we select 2 end-members: 1) a Mg-rich gabbronorite sample [7] and 2) a Ca-sulfide, both at a fine grain size (<63 μm). Starting from these end-members, mixtures are prepared, with increasing sulfide abundances% (80, 60 and 40%, respectively). Emissivity spectra were acquired at four different temperature, 100°C, 200°C, 300°C and 400°C; reflectance spectra (i=13°; e=17°, 0.8mbar) were acquired from both fresh and heated samples.

## 3. Results

Here we present preliminary results for CaS measurements. Fig. 1 shows the reflectance spectra of CaS before and after the thermal process. The heating process (pink spectra) produces a reflectance increase and a spectral contrast decrease in the VIS range (Fig. 1a). Differences are evident also in the MIR, such as the appearance of new structures after the thermal process (see arrows in figure 1). Spectra will be deconvolved using different models (e.g., Modified Gaussian Model-MGM [8]) to evaluate possible variations (e.g., band center).

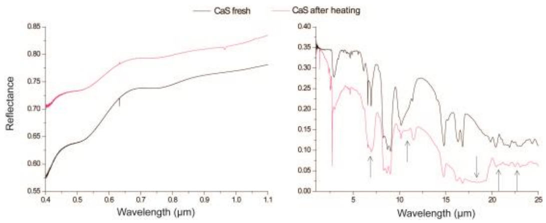


Figure 1 Reflectance spectra of CaS before (black spectra) and after heating at 400°C (pink spectra).

Fig. 2 reports the emissivity spectra of CaS at four different temperatures, showing how spectral features are affected by the sample temperature.

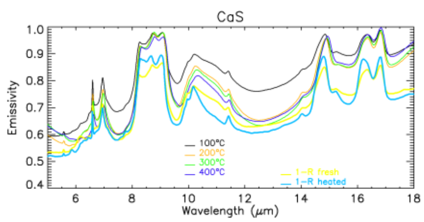


Figure 2 Emissivity spectra of CaS at surface temperature varying between 100°C (black spectrum) and 400°C (blue spectrum).

# 4. Conclusions

In this work we analyse in detail the spectroscopic behaviour of sulfide-bearing silicatic mixtures. These mixtures are important to understand the influences of different amounts of sulphide on spectra from hermean regolith. Furthermore, MESSENGER mission highlighted how a relatively short spectral range cannot be sufficient to understand the mineralogy and the composition of Mercury surface. The new mission Bepicolombo will work with image spectrometers both in the VNIR and in TIR. For this reason, we want to combine VNIR-MIR wavelengths with TIR range.

Our work will help to define indicators useful to analyze remote sensed data. Moreover, we will contribute to the creation of a spectral library to which compare results from orbit. Experience from laboratory analyses is fundamental to analyze data both from VIHI (Visible and Infrared Hyperspectral Imager) and MERTIS (Mercury Radiometer and Thermal Imaging Spectrometer).

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