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Laboratory studies on thermal modification of mineral reflectance spectra in support of OSIRIS-Rex mission

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Abstract

We are investigating in laboratory spectral property of minerals in space simulated conditions supporting the interpretation of spectroscopic data collected with OVIRS [1] and OTES [2] instruments on board of sample return NASA OSIRIS-REx mission [3].
Specifically, we are investigating how different temperatures in lower pressure environment can affect spectral features in the wavelength range from visible to far infrared. This work is aimed in producing a spectroscopic database of different minerals dust with various grain size.

1. Introduction

Interpretation of data collected by OVIRS and OTES depends strongly on the optical properties of the material, grain sizes and temperature of regolith present on Bennu' surface [4]. Spectral library of silicates, carbonates, sulphates, oxides and organic molecules are commonly obtained at room temperature and ambient pressure. Up to now few studies were performed analysing the effects of different environments on spectroscopic features of pure minerals [5]. Nonetheless, decades ago it was questioned if temperature could affect spectral property of minerals. Furthermore, changes in the environmental pressure might cause changes in spectral features. Thus, it's important to acquire spectra in vacuum and at various temperatures for better simulating the environmental conditions found on Bennu. In this way, laboratory work on mineral spectral properties are fundamental in order to give a correct interpretation of data collect from the surface of Bennu during the orbital phase of OSIRIS-REx.

2. Experimental apparatus and samples

Our experimental apparatus at INAF-Astrophysical Observatory of Arcetri allows reflectance measurements in an extended spectral range from VIS to far IR and at different temperature from 64 K to 500 K with temperature stability ±0.1 K.
Interfacing an Oxford Instruments cryostat with a Bruker FT-IR spectrometer we are able, with the proper mirror geometry, to acquire reflectance spectra of different mineral dust samples. The cold finger of the cryostat with its sample holder hosting mineral dust is placed inside a micro tail equipped with different windows transparent at each spectral range analysed. Inside the micro tail high vacuum (with pressure $<10^{-5}$ mbar) is obtained with a turbo molecular pump.
Mineral samples are prepared in our laboratory from natural mineral with grain size ranging from 1 mm to less than 20 microns. Cleaning of organic contaminants is performed with optimal procedures well validated in previous work.

3. Results

The experimental work here presented will show spectroscopic changes on reflectance spectra of mineral dust in the VIS-NIR-MIR range at temperature 64 - 500 K in vacuum. Different mineral samples in different grain size were analysed to investigate the spectral modifications in simulated space environment. Our results show significant reversible changes in spectral features observed in reflectance. Changes affect different properties of spectra like peak position and band area with a similar trend for all the samples analysed (see Fig 1).

These results will be used for implementing the spectroscopic analysis of data returned from space missions of planetary surfaces.

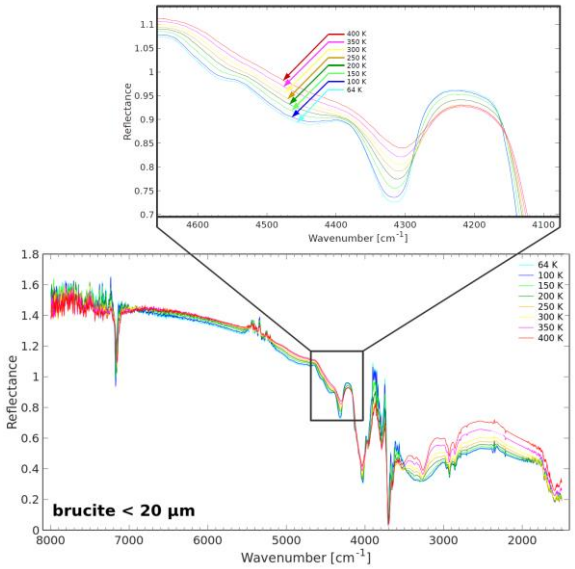

Figure 1 - Brucite reflectance spectra in medium infrared range at different temperature in vacuum.

Acknowledgements

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