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SYNTHETIC GLASSES AS ANALOGS FOR INFRARED STUDIES OF PLANETARY SURFACES

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Abstract

We present mid-infrared spectra of glasses with the chemical composition of surface areas from Mercury based on MESSENGER data. The data will be used for the interpretation of results of the MERTIS mid-infrared spectrometer on the ESA/JAXA BepiColombo mission to Mercury.

1. Introduction

Our work at the IRIS (InfraRed spectroscopy for Interplanetary Studies) laboratory produces spectra for a database for the ESA/JAXA BepiColombo mission to Mercury. Onboard is a mid-infrared spectrometer (MERTIS-Mercury Radiometer and Thermal Infrared Spectrometer). This unique device allows us to map spectral features in the 7-14 µm range, with a spatial resolution of ~500 m [1-4]. These infrared spectra allow determining the mineralogical compositions of the planetary surface via remote sensing. Material on the surface of Mercury was exposed to heavy impact cratering in its history [4]. Glass lacks an ordered microstructure and represents the most amorphous phase of a material, typical for events generated by events involving high shock pressure and temperatures [5,6]. Using synthetic materials allows us to produce infrared spectra of analogue materials based on the observed chemical composition of planetary bodies, from which no material in form of meteorites is available.

Here we present glasses with the composition of the large surface regions G1 and G2 on Mercury, based on MESSENGER data [7]. G1 is an area in the equatorial region of Mercury, and area G2 is on the southern hemisphere.

2. Samples and Techniques

Preparation of Glass: We prepared starting material mixtures of oxides (SiO_2, TiO_2, Al_2O_3, Fe_2O_3, MgO and carbonates ($CaCO_3$) with the composition of the large surface regions G1 and G2. The finely ground powder was slowly heated to 1000°C to decarbonate and subsequently vitrified in a vertical furnace at 1500°C for 2 h and quenched immediately afterwards.

Characterization: The resulting glass was embedded in resin and polished to a thin section. The amorphous character was confirmed by optical petrological microscopy. The chemical composition of the glass was analyzed using a JEOL 6610-LV Scanning electron microscope equipped with an Oxford silicon drift electron dispersive EDX system. A fully standardized quantitative analysis was performed using ASTIMEX™ mineral standards.

FTIR Analyses: For in-situ mid-infrared specular reflectance analyses we used a Bruker Hyperion 2000 System at the Hochschule Emden/Leer. We used a 1000*1000 ($µm^2$) sized aperture, for each spectrum; 128 scans were added. A Bruker Vertex 70 infrared system with a MCT detector at the Institut für Planetologie was applied for analyses of powdered material in near vacuum. To ensure high signal to noise ratio, we accumulated 512 scans for each size fraction. For background calibration, we used a well calibrated gold standard.

Figure 1: Optical microscope image of small crystallites in the glass, forming a spinifex texture.

3. Results

Optical polarization microscopy shows a glass with abundant small crystalline inclusions showing spinifex textures in glass G1 (Fig.1).

The spectra of grain size fractions for surface areas G1 and G2 on Mercury (Fig.2a, b) show Christiansen Features (CF) at 8.0-8.2µm, and a strong amorphous silicate Reststrahlen-Band (RB) at 10.3-10.5 µm. Area G1 also shows some weak crystalline features of forsterite [8] at 10.1 and 10.4 µm. Transparency Features (TF) are weak and occur at 11.8-12.2 µm.

Spectra obtained for G1 and G2 using micro-FTIR of inclusion-free spots confirm the findings.

4. Summary and Conclusions

Both glasses show a very high degree of crystallinity, even the abundant small spinifex crystals in G1 only create very weak bands in the mid-infrared.

In our presentation, we will show glasses with the compositions of many more surface areas of Mercury, as well as of models for the bulk mantle compositions of the planet.

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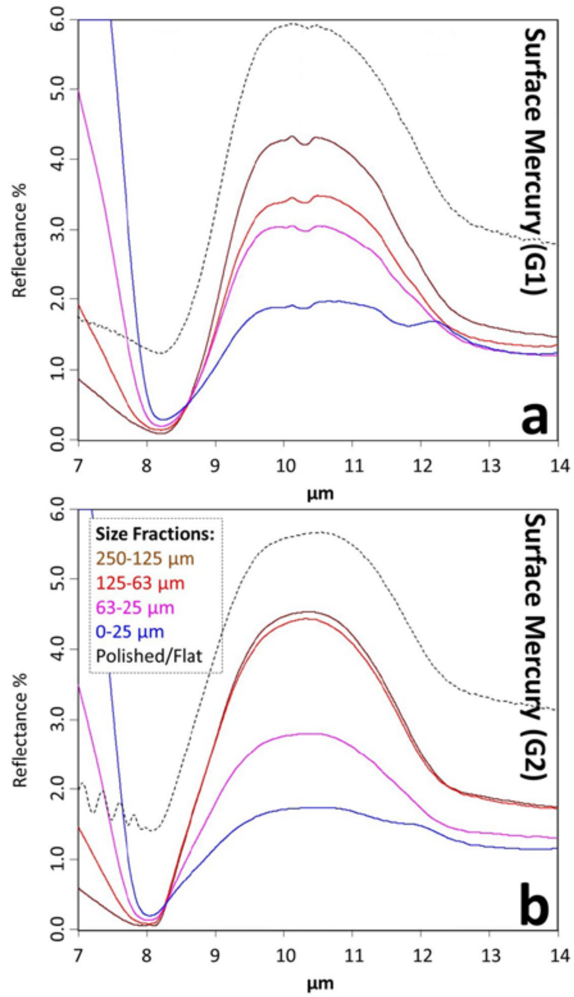

Figure 2: Mid-IR reflectance spectra of two bulk size fractions of synthetic glasses and in-situ analyses of thin sections in the range of the BepiColombo MERTIS spectrometer (in microns; µm).

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