MID-INFRARED REFLECTANCE SPECTROSCOPY OF GLASS ANALOGS FOR THE BEPICOLOMBO MISSION

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Introduction: The purpose of the IRIS (Infrared and Raman for Interplanetary Spectroscopy) laboratory is to produce spectra for the ESA/JAXA BepiColombo mission to Mercury [1,2]. The mid-infrared spectrometer MERTIS (Mercury Radiometer and Thermal Infrared Spectrometer) will map spectral features in the 7-14 µm range, with a spatial resolution of ~ 500 meters [1,2]. These infrared features will permit determining Mercury's surface mineralogy.

In order to interpret the future infrared data, we need laboratory spectra for comparison. As part of a study to build a database for this purpose, we have studied a wide range of natural mineral and rock samples such as terrestrial impact rocks and meteorites [e.g., 3-5]. However, since we do not have natural samples from surface of Mercury, we also produced synthetic analogs based on remote sensing data and modelling to fill this gap. These include synthetic glasses based on MESSENGER data and laboratory experiments [6-9].

In order to get a large petrological range of analog materials, we synthesize mixtures based on petrological experiment conducted on the basis of the surface chemistry as measured by MESSENGER. A central component for such mixtures will be glass to replicate vitric material formed by impact events and lava extrusion (i.e., Pele's tear analogues) and explosive volcanism (i.e., pyroclastic debris) [e.g. 10]. Here we present first results of a series of synthetic glasses produced for this purpose, which will be used for future mixtures and experiments.

Samples and Techniques: *Sample Production:* We synthesized analog material simulating the petrologic evolution of magmas on early Mercury under controlled temperature, pressure and oxidation state [7-9]. The glass was synthesized following a procedure described in [11] with the oxidation state controlled by exposing the sample to a CO-CO_2 gas-mixture equivalent to four orders of magnitude below the iron-wüstite buffer (IW-4). For in-situ studies we selected a series of run products from laboratory experiments which simulated the formation of the surface material under varying pressure and temperature regimes [9].

Infrared Spectroscopy: For the bulk powder FTIR diffuse reflectance analyses, powder size fractions 0-25 µm, 25-63 µm, 63-125 µm, and 125-250 µm were measured, in addition to a polished glass chip. For mid-infrared analyses from 2-20 µm, we used a Bruker Vertex 70 v infrared system with a MCT detector at the IRIS laboratories at the Institut für Planetologie in Münster. Analyses were conducted under low pressure to reduce atmospheric bands.

FTIR microscope analyses of spots in polished blocks and thin sections were conducted on the experimental runs using a Bruker Hyperion 1000/2000 System at the Hochschule Emden/Leer. We used a 250×250µm sized aperture. A Perkin-Elmer Spotlight-400 FTIR spectrometer at the University of Manchester was used to map samples using an adjoining Focal Plane Array (FPA) mapping unit with a resolution of 6.25 µm × 6.25 µm in the reflectance mode

Results: Figure 1 gives an example of the mapped area of an Mg-poor glass (5.2wt%) (sample 131_1), based on the bulk composition of the Mercurian High Magnesium Regions (HMg) [9]. Spectra were extracted from Mg-poor (5.2 wt%) glassy areas (Fig. 2). Compared with in-situ spectra of glasses with a Mg-rich composition from the Inter Crater Planes (ICP) (~ 21.5 wt% MgO; sample 121_3), we see a spectra typical for glassy materials. The single, dominating Reststrahlenband (RB) shifts with increasing MgO content (a proxy for polymerization) from 9.3 µm to 9.9 µm, and a CF from 7.9 µm to 8.2 µm.

The two bulk powders have low MgO contents: 1.6 wt% (Low Mg C) and 4.7 wt % (Low Mg B) [9]. Spectra of the different size fractions show increasing intensity with increasing grain size (Fig. 3). While the RB and CF features are similar for all size fractions, an additional Transparency Feature (TF) appears in the finest grain size fraction (0-25 µm). The Low Mg B sample has the TF at 11.7 µm, the CF at 7.8 µm and the RB at 9.4 µm. Low-Mg C shows the CF from 7.6 µm to 7.7 µm, the RB at 9.2 µm – 9.3 µm and a TF at 11.6 µm.

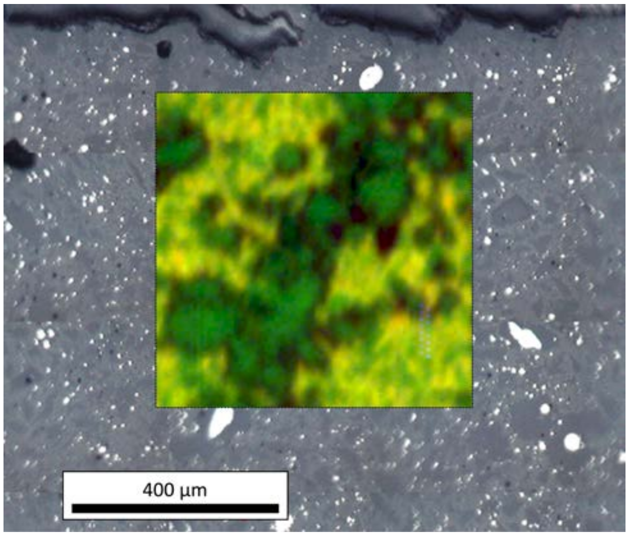

Figure 1: Colored area mapped using micro–FTIR on a polished surface of HMg region sample 131_1 [9]. FTIR spectra were extracted from the dark green region.

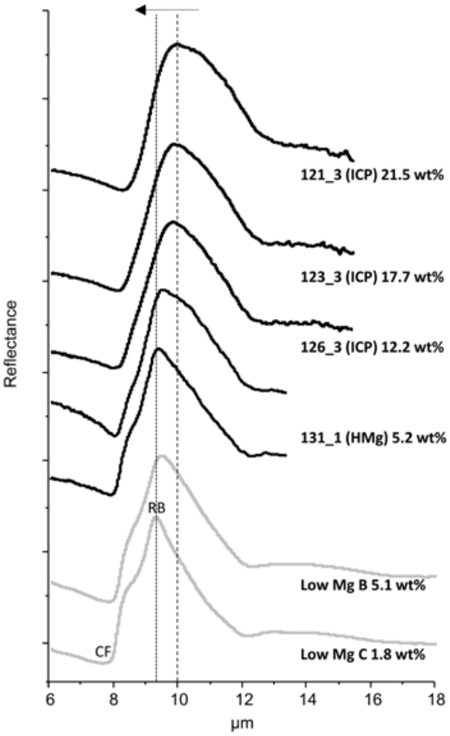

Figure 2: Micro FTIR spectra of glassy spots of experimental run products based on hermean surface composition. Horizontal line show shift of the strong Reststrahlenband (RB). CF=Christiansen Feature, ICP=Inter Crater Plains, HMg=High-Magnesium region [9].

Acknowledgments: This work was supported by DLR grant 50 QW 1302/1701 in the framework of the Bepi-Colombo mission (A.M.,I.W.,A.N.S.,M.P.R., K.B.)

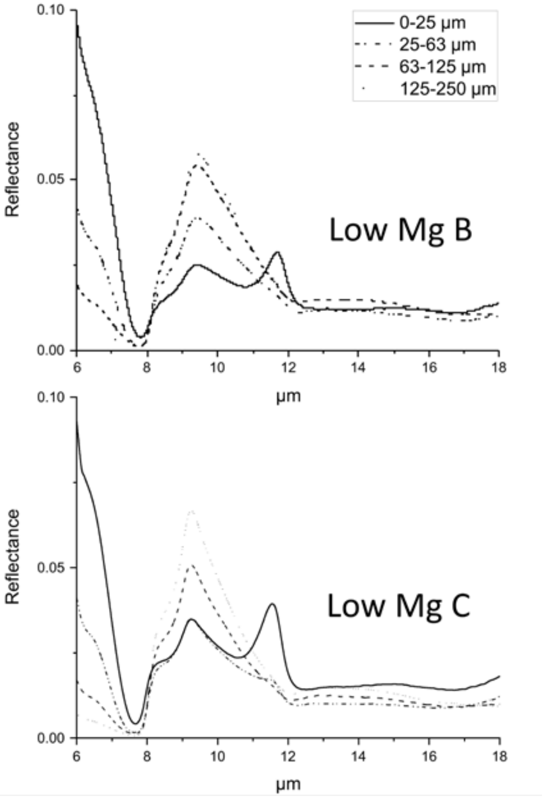

Figure 3: Bulk powder FTIR spectra of sieved size fractions of Mg poor sample Low-Mg B (5.1 wt% MgO) and Low-Mg C (1.8 wt% MgO).

Summary & Conclusions: The sieved size fractions of the bulk glass material show typical features for highly crystalline materials. They follow a trend of band shifts for CF and RB towards longer wavelengths with increasing MgO contents [3,4]. Further glasses in productions will cover higher MgO contents (>6 wt%) to provide material for the whole range of expected Mercurian regolith glass compositions [7-9].

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