GRAPHITE AS POTENTIAL DARKENING AGENT FOR MERCURY: SPECTRAL MEASUREMENTS UNDER SIMULATED MERCURY CONDITIONS. A. Maturilli[1], J. Helbert[1] and I. Varatharajan[1], [1]1Institute of Planetary Research, German Aerospace Center DLR, Berlin, Germany (alessandro.maturilli@dlr.de).

Introduction: Occasionally Mercury was considered a planet very similar to the Moon. Both are small rocky bodies in the inner solar system with thin exospheres and no large scale traces of recent geological activity. However Mercury's surface reflects much less sunlight than the Moon. Trying to explain the reasons for this difference, significant abundances of iron and titanium (and their oxides) were proposed for the Hermean surface after the first NASA MESSENGER flyby of Mercury. But once in orbit the NASA MESSENGER GRS instruments found only small abundances of iron, confirming earlier ground-based spectroscopy observations, and virtually no titanium. Therefore neither of the elements can account for this diversity. New analysis of MESSENGER data acquired for the darkest regions of Mercury's surface suggest that the unknown darkening material could be carbon, in particular as the mineral graphite [1] whose abundance in the darker regions is predicted to be 1 to 3 wt% higher than the surroundings.

Our Study: At the Planetary Spectroscopy Laboratory (PSL) of the Institute of Planetary Research (DLR, Berlin) we measured reflectance spectra for several phase angles of graphite, from UV to TIR spectral range (0.2 to 20 µm). Graphite samples have been measured fresh and then after successive steps of heating at 400°C in vacuum for 8 hours. Following the same procedure on fresh and heated material as defined for the graphite samples, reflectance spectra of Komatiite (chosen as Mercury surface simulant, after [2]) was measured alone and mixed with few % of graphite to reproduce the results from [1]. Figure 1 shows reflectance for the fresh and heated sample of Mercury surface simulant Komatiite.

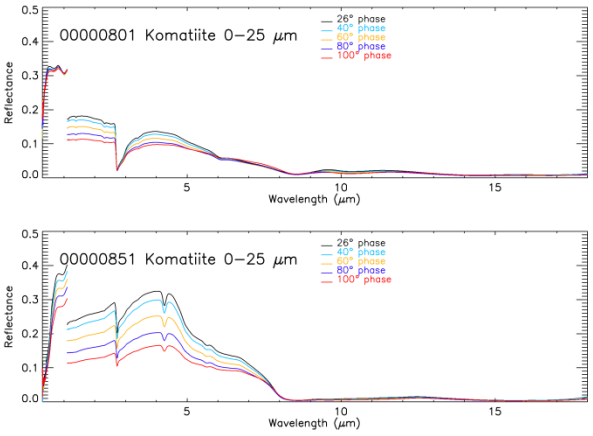

Figure 1. Mercury surface analogue Komatiite spectra (upper fresh, lower after 2 times at 400°C in vacuum).

Figure 2 shows spectra for the Komatiite/graphite mixture.

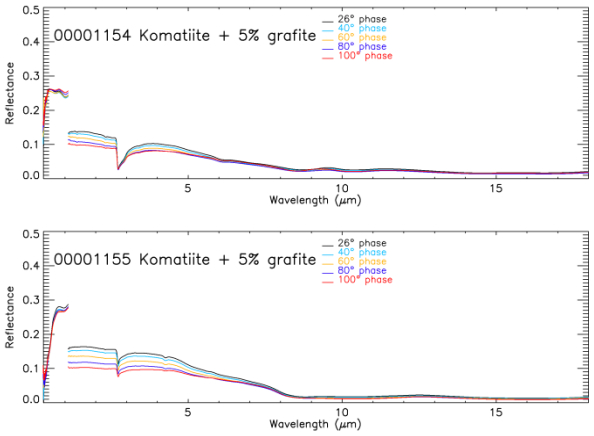

Figure 2. Mercury surface analogue Komatiite + graphite (5% in weight) spectra (upper fresh, lower after 2 times at 400°C in vacuum).

The same set of samples has been measured in emissivity, in vacuum (< 0.8 mbar) for successive cycles of several surface temperatures from 100°C to 400°C in the TIR spectral range (1 to ~ 18 µm) in preparation for the emissivity spectra that will be collected by the Mercury Radiometer and Thermal Infrared Spectrometer (MERTIS), a spectrometer developed by DLR, jointly with the Wilhelms Universität in Münster, on board of the ESA BepiColombo Mercury Planetary Orbiter (MPO) on its way to Mercury since October 2018 [3].

In Figure 3 we show the TIR emissivity spectra of pure Komatiite, graphite, and their mixture (graphite is 5% in weight). Spectra were measured for 4 different temperatures, along 2 consecutive days to reproduce day and night insulation conditions on Mercury. Graphite endmember emissivity spectra show a tiny spectral feature around 8 µm, the same feature is absent in komatiite alone but can be found when the same Komatiite is mixed with 5 wt% of graphite. Further effects of graphite mixed to Komatiite can be seen in the Christiansen Feature (CF) and surrounding regions. This indicates that MERTIS on BepiColombo will have the opportunity to detect graphite features in Mercury surface emissivity spectra in the 7-14 µm spectral range.

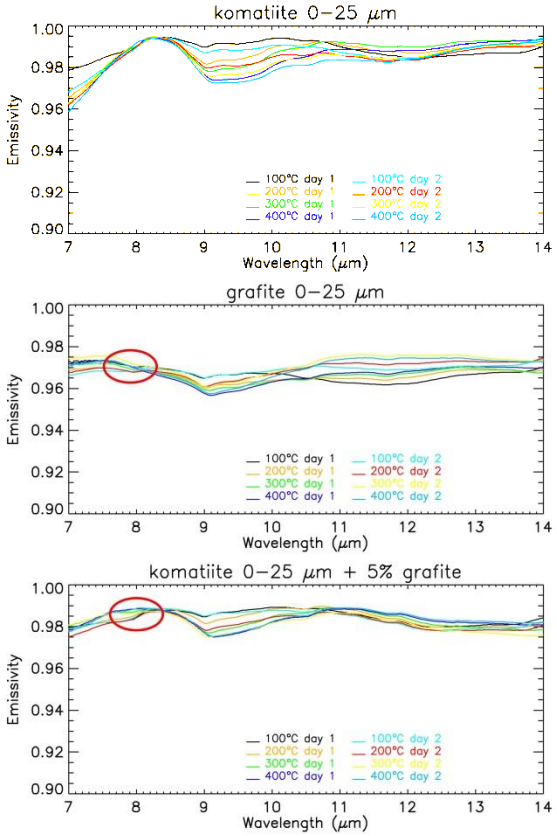

Figure 3. Emissivity spectra for the 3 Mercury analogues measured in vacuum at 100°, 200°, 300°, and 400° C. Graphite spectral feature is highlighted in the region around 8 µm.

Summary and Outlook: At the Planetary Spectroscopy Laboratory (PSL) of DLR in Berlin we measured emissivity spectra of graphite for sample temperatures from 100° to 400° C, simulating several heating/cooling (Mercury day and night) cycles. Emissivity for Mercury simulant Komatiite (pure and mixed with 5 wt. %) was measured under the same conditions. Reflectance spectra for fresh and heated samples were measured from UV to TIR spectral range for a large range of illumination angles.

A follow-up experiment is planned to continue this study using different graphite samples and a finer graphite sample (g.s. < 10 µm) to better simulate the predicted very fine particles to be found on Mercury surface. We will monitor the influence of heating temperature on the sample spectral features to understand the effect of impact heating on the graphite layer beneath the Martian crust, as explained in [1].

References:

[1] Peplowski P.N., Klima R.L., Lawrence D.J., Ernst C.M., Denevi B.W., Frank E.A., Goldsten J.O., Murchie S.L., Nittler L.R., Solomon S.C. (2016) *Nature Geoscience 9*, 273–276, doi:10.1038/ngeo2669.

[2] Maturilli A., Helbert J., St. John J.M., Head III J.W., Vaughan W.M., D'Amore M., Gottschalk M. (2014), *EPSL 398*, 58–65.

[3] D'amore M. et al. (2019) *LPSC 50 (this conference).*