AN OVERVIEW OF THE PLANETARY EMISSIVITY LABORATORY (PEL) AT DLR IN BERLIN. A. Maturilli[1], J. Helbert[1], M. D'Amore[1], [1]Institute for Planetary Research, German Aerospace Center DLR, (Rutherfordstr. 2, 12489 Berlin-Adlershof, Germany, alessandro.maturilli@dlr.de).

Introduction: The minerals found on the surface of extraterrestrial planets teach us a lot about the formation conditions and the evolution of every specific celestial body. Although on large planets very different conditions can be often found at the same time (like on Earth or Mars, with hot/warm equatorial regions and cold polar regions), the atmospheric pressure, distance to the sun, inclination angle and other paramenters characterize the range of minerals that is possible to be found stable on the surface.

To have a meaningful database of minerals spectra to be used for the analysis of remote sensing or in-situ spectroscopic data, one needs to simulate as much as possible the surficial environmental conditions on the planet of interest.

For such reasons, in the Planetary Emissivity Laboratory (PEL) at German Aerospace Center (DLR) in Berlin we can, using two distinct instrument working in parallel perform the following kind of measurements on planetary analogue materials or any kind of material of interest:

1) emissivity measurements at high temperatures and under vacuum conditions,
2) bi-directional reflectance measurements at room temperature and under vacuum conditions,
3) transmission measurements at room temperature and under vacuum conditions,
4) emissivity measurements at low/moderate temperatures and under purging conditions,
5) bi-directional reflectance measurements at room temperature and under purging conditions.

The PEL set-up: The PEL is equipped with a Bruker Vertex 80V instrument, coupled to an evacuable high temperatures emissivity chamber and an older Bruker IFS 88 attached to a purged low/moderate temperatures emissivity chamber. The two instruments can work independently and in parallel, since they do not share any crucial device. Figure 1 shows the optical table where the two instruments, the external chambers and the other complementary devices are displaced.

The new generation Bruker VERTEX 80V FTIR spectrometer has a very high spectral resolution (better then 0.2 cm-1), and a resolving power of better than 300,000:1, and can be operated under vacuum conditions to remove atmospheric features from the spectra. To cover the entire from 1 to 100 μm spectral range, two detectors, a liquid nitrogen cooled MTC (1-16 μm) and a room temperature DTGS (15-100 μm) and two beamsplitter, a KBr and a Mylar Multilayer, are used. However, the system DTGS+Multilayer is usually operated under its full capability, since it allows to measure spectra until 300 μm.

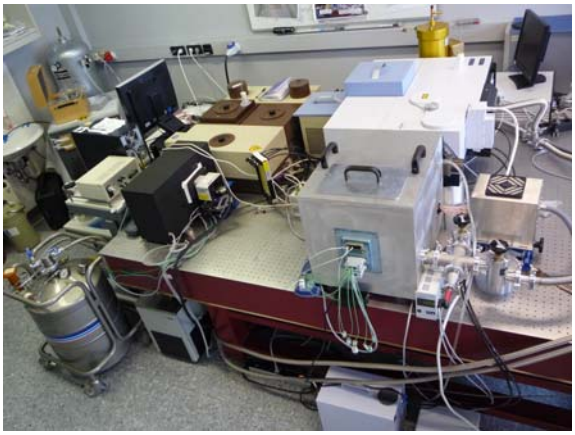

Figure 1: The PEL set-up at DLR, Berlin

The spectrometer is currently coupled to a newly completed planetary simulation chamber see Figure 2), that can be evacuated so that the full optical path from the sample to the detector is free of any influence by atmospheric gases. The chamber has an automatic sample transport system which allows maintaining the vacuum while changing the samples.

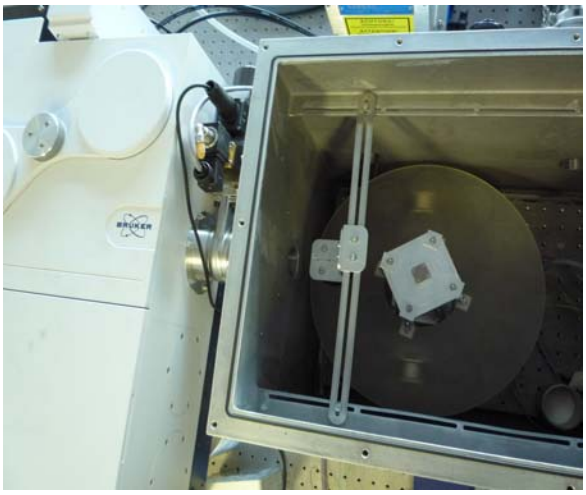

Figure 2: The planetary simulation chamber (top cover was removed)

The induction heating system that is permanently installed in the new chamber allows heating the samples to temperatures of up to 700K permitting measurements under realistic conditions for the surface of Mer-

cury. The chamber can be even used as an independent vacuum-oven, where to thermally shock minerals to be furtherly measured in reflectance. A long list of tests have been performed to characterize the new vacuum chamber and all the devices used for the emissivity measurements of high temperature minerals. Details can be found in [4].

The other instrument available in the laboratory is an older Bruker IFS 88 with attached an emissivity chamber (Figure 3), which has been developed at DLR. A heater placed in the chamber is used to heat the sample cups from the bottom, from 20° up to 180° C. The thermal radiation emitted normal to the surface by the sample or the calibration blackbody is collected by an Au-coated parabolic off-axis mirror and reflected to the entrance port of the spectrometer. The chamber is purged with dry air to remove particulates, water vapor and CO_2. By means of the cooling mechanism, the chamber temperature can be set and maintained constant, typically at 10° or 20° C, but if needed its temperature can be set to below zero. The chamber and instrument are described in major details in [2, 3].

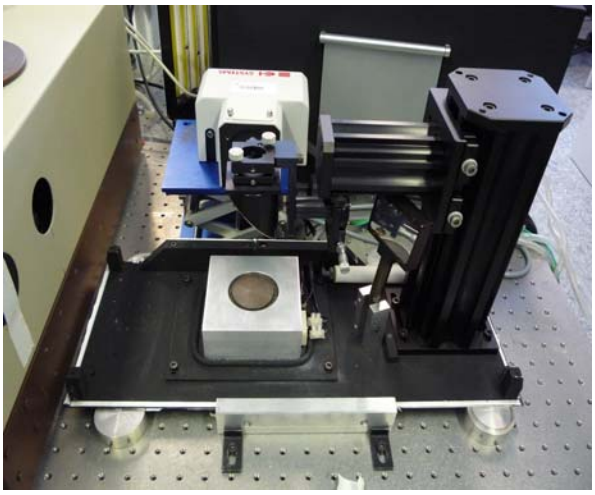

Figure 3. The old emissivity chamber (envelope was removed, visible in the background)

By means of the Bruker A513 accessory, and VERTEX 80V instrument, we obtain bi-directional reflectance of minerals, with variable incoming and outcoming angles (between 13° and 85°). We can measure room temperature samples, under purged air or under vacuum conditions, covering the 1 to 100 µm spectral range. Such measurements can be used even to complete the emissivity measurements we can perform, especially in the case of a very limited amount of the available material. Similarly, a Harrick Seagull™ variable angle reflection accessory mounted in the Bruker IFS 88 allows to measure bi-directional reflectance (with continuously variable angle of incidence from 5° to 85°) of minerals at room temperature, under purging conditions in the extended spectral range from 0.4 to 16 µm. The possibility to extend our measurements to the visible region of the electromagnetic spectrum is a very important recently obtained feature at the PEL laboratory, that provide us the opportunity to support the MASCS camera on NASA MESSENGER mission.

The Bruker A480 parallel beam accessory mounted in the VERTEX 80V is used to accurately measure transmission of thin slabs of material, optical filters, optical window materials, etc, in the complete 1 to 100 µm spectral range. Such a device, allows us to avoid refraction (causing focus and lateral beam shifts), typical in this kind of measurements. This unit is particularly useful to test and characterize the optical components in our instruments, its performances and degradation features.

Summary: The PEL provide the planetary community already today with emissivity measurements highly complementary to existing spectral databases. With the recently completed upgrade the PEL allows unique measurements with a strong focus on airless bodies and extreme conditions as the ones BepiColombo and MESSENGER will encounter at Mercury, over the extremely wide spectral range from 1-100 µm for fine grained samples. Two accessories permit complementary measurements of reflectance and transmission in the same large spectral range, that can be easily extended to until 300 µm. A second instrument is used to measure emissivity at low/moderate temperatures, and bi-directional reflectance spectra at room temperature of samples, under purged air conditions.

References: [1] A. Maturilli, J. Helbert et al. (2006), *PSS 54*, 1057–1064. [2] A. Maturilli, J. Helbert, et al. (2008), *PSS 56*, 420–425. [3] Helbert, J. and Maturilli, A. (2009), *EPSL 285*, 347–354. [4] Helbert, J. and Maturilli, A. (2011), *This conference*.