Mercury in a box – in the Planetary Emissivity Laboratory (PEL) at DLR Berlin. Jörn Helbert[1], Alessandro Maturilli[1], Mario D'Amore[1] [1]Institute for Planetary Research, German Aerospace Center DLR, (Rutherfordstr. 2, Berlin-Adlershof, Germany, joern.helbert@dlr.de).

Introduction: Analyzing the surface composition of Mercury's regolith from remote-sensing measurements is a challenging task. In support of the National Aeronautics and Space Agency's MErcury Surface, Space ENvironment, GEochemistry and Ranging (MESSENGER) mission and especially in preparation for the Mercury Radiometer and Thermal Infrared Spectrometer (MERTIS) instrument on the BepiColombo mission of the European Space Agency and the Japan Aerospace Exploration Agency, we are completely refurbishing the Planetary Emissivity Laboratory (PEL) at Deutsches Zentrum für Luft- und Raumfahrt (DLR) in Berlin. The upgraded PEL allows measurement of the emissivity of Mercury-analogue materials at grain sizes smaller than 25 µm and at temperatures of more than 400°C, typical for Mercury's low-latitude dayside. The PEL development follows a multi-step approach. We have already obtained emissivity data at mid-infrared wavelengths that show significant changes in spectral behavior with temperature indicative of changes in the crystal structure of the samples. We are currently testing new calibration targets that will allow the acquisition of emissivity data over the full wavelength range from 1 to 50 micrometer with good signal-to-noise ratio.

The PEL: The Institute for Planetary Research has an expertise in spectroscopy of minerals, rocks, meteorites, and organic matter, build up in more than two decades. The available equipment allows spectroscopy from the visible to TIR range using bi-conical reflection and emission spectroscopy. The institute has an outstanding heritage in designing and building infrared remote-sensing instruments for planetary missions.

The PEL has been operating in various configurations for the last 10 years. The laboratory experimental facilities consist of the main emissivity spectrometer laboratory, a supporting spectrometer laboratory for reflectance measurements, sample preparation facilities and an extensive collection of rocks and minerals.

The heart of the spectroscopic facilities is the Planetary Emissivity Laboratory (PEL) which has been completely renewed in the last two years. The PEL allows currently to measure the emissivity of planetary analogue materials from 3-50 µm for very fine grained samples.

Figure 1: View of the main facility in the PEL

The laboratory spectrometer unit has been upgraded in 2006 with a new Bruker VERTEX 80V FTIR spectrometer. This instrument 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 50 µm spectral range, two detectors, a liquid nitrogen cooled MTC (1-16 µm) and a room temperature DTGS (15-50 µm). two beamsplitter, a KBr and a Multilayer, and two entrance windows, KBr and CsI are used to measure the same target.

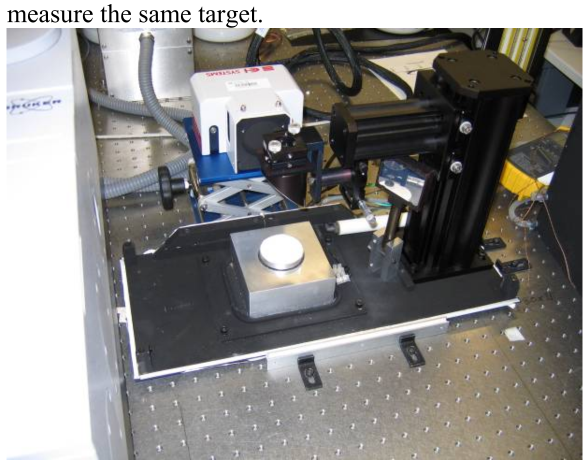

Figure 2: Open emissivity chamber (top cover removed)

The spectrometer is currently coupled to an emissivity chamber which has been developed at DLR. It is a double-walled water-cooled box with three apertures: a 15 cm squared door used to insert the cup in the box, a 5 cm rounded opening through which the beam is directed to the spectrometer and a 5 cm opening facing the attached blackbody unit. A heater is placed in the chamber and is used to heat the cup with samples from the bottom. The thermal radiation emitted normal to the surface by the sample or the 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 vapour and CO2. Further details can be found in [1, 2].

We are currently in the process of replacing this device with a planetary simulation chamber. The new chamber can be evacuated so that the complete 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 to maintain the vacuum while changing the samples.

Figure 3 Top: Schematic view of the new planetary simulation chamber- Bottom: Chamber casing at manufacturer

The main highlight however will be the new induction heating system that will be permanently installed in the new chamber. It will allow to heat the samples to temperatures of up to 700K permitting measurements under realistic conditions for the surface of Mercury. In a next step we will add a second heating source above the sample which will allow to force thermal gradients in the samples which is a much more realistic representation of the thermal conditions on planetary surface.

We are currently evaluating a new high temperature calibration source (Fig 4). Instead of using an external blackbody this source is a steel disc with high emissivity paint and an embedded temperature sensor. The steel material allows to heat the source directly with the induction system and the source can therefore reach temperatures up to 500°C. The stability of the paint and its longterm behaviour is currently under investigation.

Figure 4 Evaluation of a new calibration target with the induction heating system

Summary: The PEL can provide the planetary community already today with emissivity measurements highly complementary to exisiting spectral databases. With the 2009 upgrade the PEL will allow unique measurements with a strong focus on airless bodies and extreme conditions as for example BepiColombo and MESSENGER will encounter at Mercury. This will be especially benefical for MERTIS the thermal infrared imaging spectrometer on BepiColombo [1,3,4,5]. The PEL will routinely obtain emissivity measurements over the extremely wide spectral range from 1-50 µm for fine grained samples. This has not only applications for Mercury. The measurements at 1 µm will for example allow for the first time a direct interpretation of the surface observations obtained by VIRTIS on VenusExpress through the atmospheric windows.

References: [1] A. Maturilli, J. Helbert et al. (2006), *PSS 54*. [2] A. Maturilli, J. Helbert, et al. (2007), *PSS*. [3] Helbert, J. et al. (2007), *ASR 40*, DOI:10.1016/j.asr.2006.11.004 [4] J. Benkhoff, J. Helbert, et al. (2006) ASR, 38, 4 [5] H. Hiesinger and J. Helbert (2008) *PSS* in press