Facing the heat - Obtaining near infrared real emissivity spectra at Venus surface temperatures. J. Helbert[1], A. Maturilli[1] and N. Müller[1], [1]Institute for Planetary Research, DLR, Rutherfordstrasse 2, 12489 Germany - joern.helbert@dlr.de

Introduction: 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 transmittance and emission spectroscopy. The institute has an outstanding heritage in designing and building infrared remote-sensing instruments for planetary missions.

The heart of the spectroscopic facilities is the Planetary Emissivity Laboratory (PEL) which has been completely refurbished in the last two years. We will report here on the next development step of the PEL, which is the addition of a planetary simulation chamber. This chamber will allow to measure samples at temperatures up to 500°C and under vacuum. After this upgrade the PEL will be the first lab that can routinely measure the emissivity of fine grained samples from 1 to 50 μm over an extremely wide range of temperatures.

Planetary Emissivity Laboratory: An emissivity spectrometer laboratory has been operating in various configurations at DLR for the last 10 years [1]. 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 Planetary Emissivity Laboratory (PEL) in its current configuration was initiated by the installation of a new Bruker VERTEX 80V Fourier Transform Infra-Red (FTIR) spectrometer in 2006. This spectrometer has a very high spectral resolution (better then 0.2 cm^{-1}) and a resolving power of better than 300,000:1, and it can be operated under vacuum conditions to remove atmospheric features from the spectra. To cover the entire spectral range from 1 to 50 μm, two detectors, a liquid-nitrogen-cooled microthermocouple (MTC) (1-16 μm) and a-room temperature deuterated triglycine sulfate (DTGS) detector (15-50 μm), two beamsplitters (KBr and multilayer), and two entrance windows (KBr and CsI) are used to measure the same target.

High temperature emission spectroscopy: The whole setup is very versatile and can provide measurements for a wide range of planetary application. However one goal that was always in mind during the planning and building up was obtaining emissivity spectra at a temperature range that would include Venus and Mercury dayside temperatures and with a wavelength coverage that would include the whole IR channel of VIRTIS on Venus Express. [2]

For the work we will presented here, a test setup was used building on the existing facility in the PEL. The main challenge to obtaining emissivity measurements at elevated temperatures is heating the sample without heating up the sample environment. The PEL will use a new and unique approach for heating the samples. Instead of a placing the sample cup on a heater and heating the sample cup by thermal conduc-

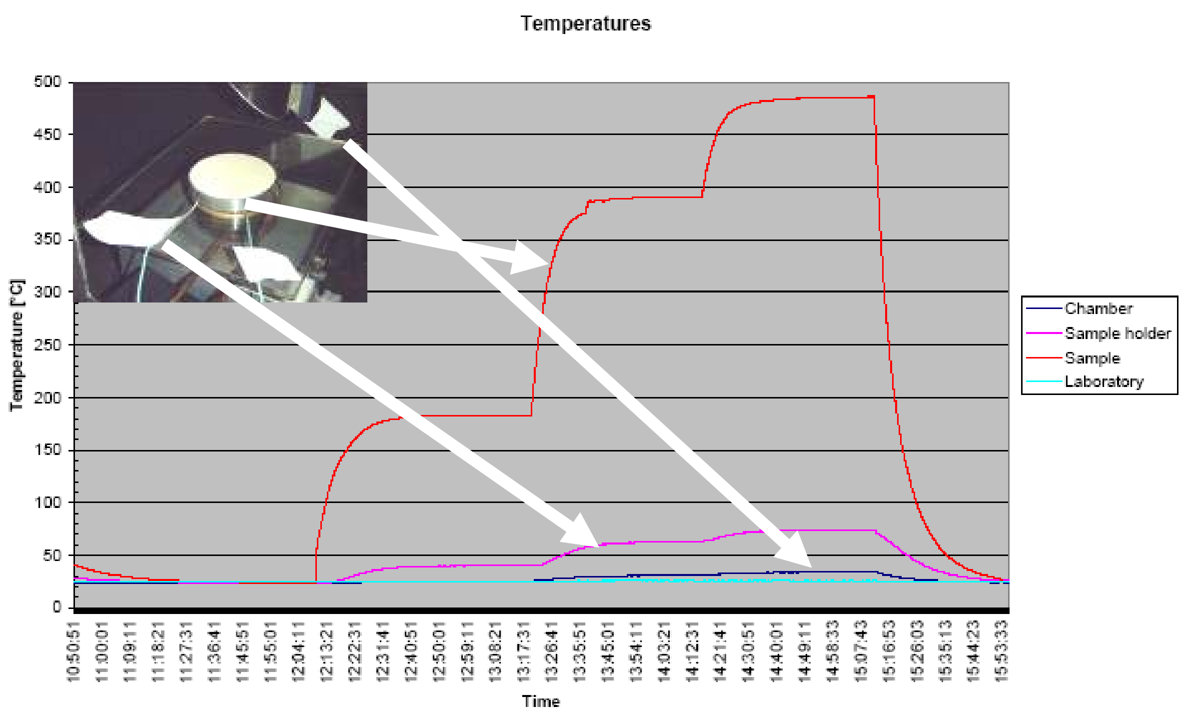

Figure 1 Temperature profiles obtained during first test of the induction heating system

tion, the samples are placed in a stainless steel cup that is heated by an induction system. In the laboratory setup, a Linn Hightherm HTG-1500 induction heating system is used with a cooper pancake coil. Inside the coil water is circulated. The steel cup is placed on a glass ceramic plate, which in turn is placed on the coil. The system is placed inside the emissivity chamber and the chamber is sealed with a foam cover. To evaluate the thermal environment, three type K thermoelements with glass silk insulation are placed inside the chamber, one underneath the cup to provide its temperature, one placed approximately 2 cm away from the edge of the cup fixed to the glass plate with tape, and the third suspended inside the chamber about 10 cm away from the sample and the chamber walls. Finally, as a reference, a fourth thermoelement is placed outside the chamber to monitor the laboratory temperature. For the final setup the thermoelements will be replaced by a non-isolated type that will be inserted in the cups and fixed with ceramic glue that is temperature stable up to at least 800°C.

Figure 1 shows the temperature profiles recorded during one measurement series with an OMEGA TC-8 data logger. As can be clearly seen, the approach using an induction system actually does allow heating a sample to high temperature without heating the environment. This is an important point for emission spectroscopy, where the main concern is to minimize the thermal radiation from the environment. While the steel cup containing the sample reaches a temperature of up to 480°C, the sensor on the glass plate only 2 cm away from the sample cup never records more than 70°C. The increase in chamber temperature is less than 5°C, making the contribution of thermal radiation from the environment to the measured signal almost negligible.

The setup uses an internal calibration source that consist of a coated steel plate. A thermoelement is imbedded in the steel plate allowing to assess the temperature. Due to its base material the calibration source can be heated by the induction system similarly to the steel sample cups. The coating of the calibration source is characterized using our standard setup. This allows to link the high temperature measurements directly with the measurements obtained using the standard setup.

Application to Venus: The laboratory work we are currently starting is in direct support of our work on VIRTIS [3,4,5]. Using the atmospheric windows in the near infrared we have mapped brightness variations on the surface of Venus which we associate with emissivity variations. These variation which show correlations with geological units are indicative of variations in the surface composition of Venus. An example from [3] is shown in Figure 2. For the Lada Terra region of Venus the analysis indicates a higher than average emissivity for fresh lava flows and a lower than average emissivity for the old tesserae terrain.

In order to draw any conclusions on actual mineralogy it is necessary to obtain emissivity values for appropriate analog materials at realistic temperatures in the same wavelength range. So far there are no such measurements available. The applicability of low temperature reflectance spectra converted to emissivity using Kirchoff's law leaves a large uncertainty.[6]

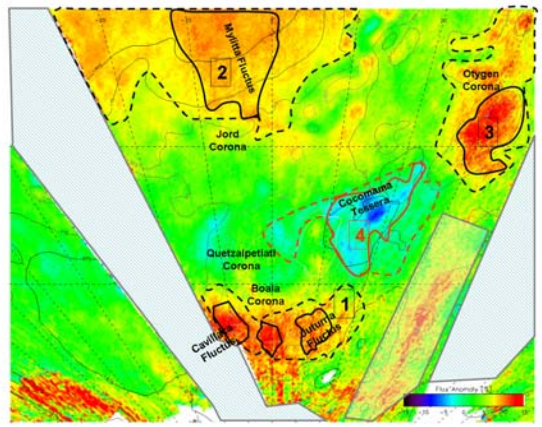

Figure 2 Brightness anomalies observed in the Lada Terra region of Venus with VIRTIS on Venus Express [3]

We have just started to work towards measurements in this range. For a first set of test measurements we will focus on anorthosite and basalts as typical end-members for a very simplified surface mineralogy.

Conclusions: The PEL will allow to obtain a unique new set of measurements that will greatly support the analysis of data retrieved using the near infrared windows of Venus. It will also strongly support the design of camera and spectrometer system for future Venus missions [7].

We will present here the very first result of this exciting new work.

References:

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