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Obtaining near infrared real emissivity spectra at Venus surface temperatures.

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Abstract

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.

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 Planetary Emissivity Laboratory

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 refurbished 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 emissivity spectrometer laboratory has been upgraded in 2006 with a new Bruker VERTEX 80V FTIR spectrometer. 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 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) and two beamsplitter, a KBr and a Multilayer are used to measure the same target.

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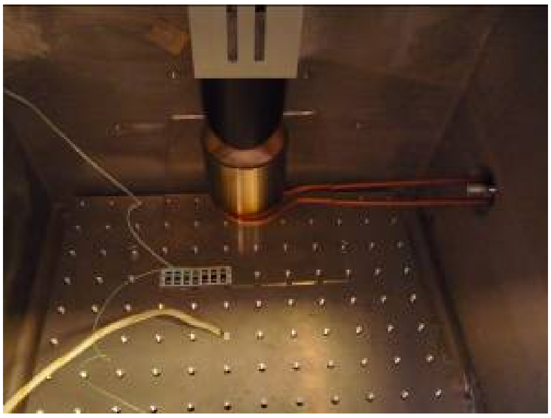

Figure 2: Open emissivity chamber (top cover removed)

We are currently in the process of replacing this chamber 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 maintaining the vacuum while changing the samples.

The main highlight however will be the new induction heating system that will be permanently installed in the new chamber. It will allow heating the samples to temperatures of up to 700K allowing measurements under realistic thermal conditions for the surface of Venus.

Application to Venus: The laboratory work we are currently starting is in direct support of our work on VIRTIS [3,4]. 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 variations 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.[%]

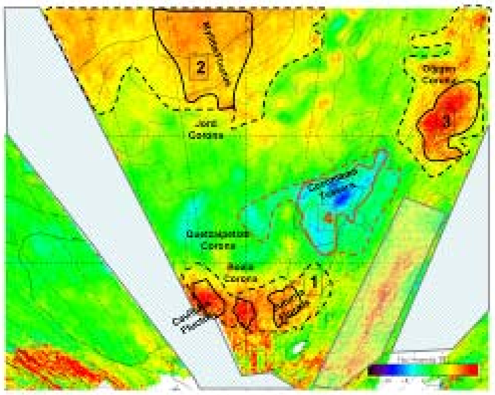

Figure 2 Brightness anomalies observed in the Lada Terra region of Venus with VIRTIS on Venus Express [3]

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 endmembers 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 [6]. We will present here the very first result of this exciting new work.

References

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