Laboratory studies of thermal space weathering on airless bodies. J. Helbert[1], A. Maturilli[1] and S. Ferrari[1], [1]Institute of Planetary Research, DLR, Rutherfordstrasse 2, 12489 Berlin, Germany (joern.helbert@dlr.de).

Introduction: Deriving the surface composition of Mercury from remote sensing hyper spectral data is a challenging task. Mercury's surface has a low iron abundance, which complicates the application of "traditional" space weathering approach. In addition the high temperatures on Mercury lead to previously unseen changes in the spectral characteristics, which we call "thermal space weathering".

The Planetary Emissivity Laboratory (PEL) at DLR in Berlin was setup specifically to study the effects of high temperatures on the spectral characteristics of planetary analog materials. It allows characterizing "thermal space weathering" and adds temperature as another important factor for the creation of spectral libraries.

Thermal space weathering can produce reversible as well as irreversible changes in the spectral characteristics of materials. In comparison to "traditional space weathering" it acts on much shorter timescales. We are going to present a number of examples for thermal space weathering effects in the visible as well as infrared spectral range.

The PEL instrumental setup: The PEL facility in Berlin is currently equipped with three Bruker Fourier Transform Infrared-Spectrometers (FTIR) as well as a portable XRD/XRF instrument. All spectrometers can be operated under vacuum to remove atmospheric features from the spectra. In addition PEL has extensive sample handling, preparation and storage facilities.

Two Bruker VERTEX 80V spectrometers are equipped with external chambers to measure emissivity. One spectrometer is optimized for the spectral range from 1 to 100 µm with an extension to 0.6 µm currently ongoing. A newly installed second VERTEX 80V is optimized for the spectral range from 0.2 to 1 µm, covering the very important UV range.

An external evacuable chamber allows measuring emissivity for sample temperatures from 50°C to higher than 800°C [1,2]. An innovative induction heating system allows heating the samples uniformly suppressing thermal gradients. For sensitive samples the chamber can also be purged with nitrogen during the measurements. An iron buffer is placed in the chamber to trap excess oxygen. Several temperature sensors allow characterizing the thermal environment precisely while a webcam can monitor the sample during the heating experiments.

A second emissivity chamber for measurements at low to moderate temperatures can be cooled down to 0°C. Samples can be heated from room temperature to 150°C in a purging environment.

A Bruker A513 accessory can be used in both spectrometer to obtain biconical reflectance with variable incidence angle i and emission angle e between 13° and 85° at room temperature, under purge or vacuum conditions. The combination of both spectrometers allows covering the spectral range from 0.2 to 100 µm in reflectance. Samples can be measured before and after exposure to high temperatures in reflectance to characterize irreversible changes in the spectral characteristics.

Examples of thermal space weathering: We have obtained reflectance spectra in the visible spectral range of magnesium, calcium and manganese sulfides before and after thermal processing at Mercury dayside temperatures in vacuum conditions as analog for the hollow forming material [2]. The spectral contrast of all samples is strongly affected by the heating. Both the spectral slope and the color observed before and after thermal processing showed significant changes. We attribute the spectral changes in the visible to an annealing of samples' color centers.

Focusing on the thermal infrared spectral range we could show for the first time experimentally and numerically, how the thermal emissivity spectra of an Mg-rich olivine significantly change as a function of temperature [3]. The temperature variation during Mercury daytime modifies the olivine spectrum shifting in wavelength its emissivity features, simulating the spectrum of an olivine strongly enriched in iron (a Fa abundance increase from 8% to 23%).

Based on the elemental composition of Mercury's surface, provided by the NASA MESSENGER spacecraft we studied a range of terrestrial komatiites as well as a synthetic komatiite at PEL [4]. Our measurements show that spectral changes between fresh and thermally processed samples occur in in the visible and the thermal infrared, but are stronger in the visible range, with reddening affecting all the samples, while darkening is more selective. The synthetic sample, which is nearly iron-free, is most strongly affected. We attribute the spectral changes in the visible again to a removal of samples' color centers.

References: [1] Helbert, J. et al. 2013. *Earth and Planetary Science Letters* 371:252-257. [2] Helbert J, Maturilli A, D'Amore M (2013) Earth Planet Sci Lett 369-370:233–238. doi: 10.1016/j.epsl.2013.03.045 [3] Helbert J, Nestola F, Ferrari S, et al. (2013) Earth Planet Sci Lett 371-372:252–257. doi: 10.1016/j.epsl.2013.03.038 [4] Maturilli A, Helbert J, St. John JM, et al. (2014) Earth Planet Sci Lett 398:58–65. doi: 10.1016/j.epsl.2014.04.035