Measuring asteroid analogs at the Planetary Spectroscopy Laboratory at DLR.

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Introduction: Studying well-characterized analogs in the laboratory can provide important insights supporting the analysis of data returned by upcoming and past missions to asteroids. Especially fundamental question like the variation of emissivity with emission angle or the change of spectral characteristics with temperature can be best addressed using basic analog materials [1,2,3]. The Planetary Emissivity Laboratory (PEL) at DLR in Berlin can provide a wide range of measurements on analogs as well as meteoritic samples to support the Hayabusa sample analysis. The currently ongoing upgrades will enable PEL also to handle efficiently a wide range of extra-terrestrial samples.

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. 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 [4]. 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. 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.

A Bruker 66V provides supporting reflectance measurements in the spectral range from 1-50 µm using a Harrick Seagull™ variable-angle reflection accessory.

References: [1] Davidsson, B. J. R. et al 2015. *Icarus* 252: 1–21. [2] Maturilli, A. et al. 2014. 45th Lunar and Planetary Science Conference. pp. 1341-1342. [3] Vernazza, P. 2007. *Icarus* 207:800-809. [4] Helbert, J. et al. 2013. *Earth and Planetary Science Letters* 371:252-257.