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Infrared spectroscopy of Mercury analogue materials under simulated Mercury surface temperature conditions

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Infrared spectroscopy is a powerful technique for the exploration of planetary surfaces with remote sensing observations [e.g., 1]. The MERTIS (Mercury Radiometer and Thermal Infrared Spectrometer) instrument onboard the BepiColombo spacecraft is designed to explore the surface mineralogy of Mercury in the wavelength region from $7\,\mu m$ to $14\,\mu m$ [2]. Mercury‘s surface reaches dayside temperatures of about $700\,K$ [3]. It is well known that bondings between atoms change with temperature, resulting in infrared spectra changes with temperature [4]. In particular, rock-forming minerals like silicates show distinct absorption bands in the infrared due to molecular vibrations, for example, of Si-O bondings [4]. To accurately understand and correctly interpret returned MERTIS data, it is necessary to collect laboratory data of analogue materials under condition similar to Mercury [5]. It is known from previous investigations [5] that the Reststrahlenbands of olivine shift with temperature. In this work we report on temperature effects on Mercury analogue materials in ambient air. At the IRIS (Infrared & Raman for Interplanetary Spectroscopy) laboratory in Münster we used a Bruker VERTEX 70v IR spectrometer together with a Harrick heating stage in a Praying Mantis Diffuse Reflectance Accessory to measure mid-infrared reflectance of mineral powder samples with different grain sizes at increasing temperatures. We report on our spectral results for a natural olivine with Fo_{91} with a grain size range between $63\,\mu m$ and $125\,\mu m$ as well as a natural labradorite with a grain size range between $90\,\mu m$ and $125\,\mu m$. Spectra were collected at 26, 75, 150, 200, 250, 300, and 350 degrees Celsius with a liquid nitrogen cooled MCT detector under normal ambient pressure. To ensure complete thermal equilibrium of our measured samples, we heated them to higher temperatures and subsequently cooled them to the temperatures at which the spectra were taken. For background calibration, we used a commercial diffuse reflectance gold standard (INFRAGOLD). Our results confirm the temperature-dependent shift of the strongest silicate feature in olivine spectra observed by [5]. For the shift of the peak position of this feature we calculated a shift function depending on the temperature in the form of $\mathrm{R}_{max}[\mu m] = 0.00027\frac{\mu m}{K} \cdot x[K] + 10.454\mu m$ ($R^2 = 0.92$). Differences in the intensity of the spectra between [5] and our work are most likely due to smaller grain sizes of our samples. We are also planning on presenting results obtained from evacuated samples (down to $10^{-6}\,mbar$), which are close to pressures existing on Mercury.

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