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Experimental Space Weathering: A coordinated LIBS, TEM, VIS and NIR/MIR study

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We conducted pulsed infrared laser irradiation experiments, in order to simulate space weathering triggered modifications of planetary surfaces not protected by an enveloping atmosphere [1,2], e.g., Mercury. Our work is embedded in the framework of the BepiColombo space mission to Mercury [3]. The MErcury Radiometer and Thermal Infrared Spectrometer (MERTIS), an onboard spectrometer will deliver surface data in the range of 7 – 14 μm once it reaches orbit in 2024 [4]. Space weathering effects known from other Solar System bodies are likely to be very prominent on Mercury due to its proximity to the Sun, the lack of a protective atmosphere and its weak magnetic field [5]. Space weathering effects, e.g., implantation of solar wind in regolith material, sputtering and (micro) meteorite impacts modify the planetary surface and thus, therefrom obtained spectral data in the VIS/NIR range considerably (e.g., reddening and darkening of spectra) [6–9]. We expect modifications induced by space weathering, known from the VIS/NIR range also to show in the mid infrared range, probably by amorphisation or similar still unknown effects [2,10]. Our approach is therefore threefold: a) alter analog material artificially by pulsed laser experiments, b) investigate altered analog material spectrally (VIS/NIR and MIR range) and c) conduct transmission electron microscopy (TEM) studies on selected weathered grains to better understand the nanostratigraphy developed by irradiation and its impact on the resulting infrared spectra. Here, we report on results obtained from the first set of experiments. Characteristic upper mantle minerals were taken as analog material, Mg-rich olivine and pyroxene, were ground into a powder ($<$ 160 μm), slightly compressed into pellets and subsequently irradiated under high vacuum conditions ($\sim 10^{-6}$ mbar) with a pulsed ($\sim$ 8ns) infrared laser at a fluence of $\sim$ 2 Jcm^{-2}. From the irradiated pellet surfaces, VIS/NIR and MIR spectra were obtained and selected grains were chosen from which TEM samples were obtained.

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