MID-INFRARED SPECTROSCOPY OF EXPERIMENTALLY SHOCKED MURCHISON CM2 MATRIX: COMPARISON WITH ASTRONOMICAL SPECTRA OF CIRCUMSTELLAR DUST

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Introduction: Collisions between planetesimals are regarded to be one of the major processes of dust formation in the debris disk phase of evolving young stars (e.g. [1]). Astronomical infrared observations allow us to obtain mineralogical information about micron-sized dust in such objects, and thus give us insight into the dust formation processes and the dust itself [2]. To interpret astronomical infrared data, laboratory spectroscopic measurements of dust analogs are needed. If dust is produced by impacts on planetesimals, it would go through significant shock processes, which would change the mineralogical and thus spectral properties of the original material. Here we present the results of mid-infrared spectroscopic measurements of the experimentally shocked hydrated carbonaceous chondrite Murchison (CM2). The previous shock experiments [3, 4] suggested that hydrated asteroids produce dust particles during collisions at a much higher rate than anhydrous asteroids.

Samples and Techniques: The Murchison samples (shocked at peak pressures of 10, 21, 26, 28, 30, 34, 36 and 49 GPa) were recovered from previous shock experiments [3]. Mid-infrared absorption spectra were taken using a continuum Nexus 670 FTIR infrared microscope.

Results: The measured infrared spectra show significant changes in the material with increasing shock pressure. The dominating phyllosilicate band at 10.2 μm is replaced by a SiO₂ glass feature at 9.9 μm. At 21 GPa, an olivine feature appears at 11.2 μm and becomes finally the strongest band at 36 GPa. The mid-infrared spectrum of the matrix shocked at 34 GPa (Fig. 1, thick solid line), just above the pressure needed to disrupt the material and thus to form dust, is similar to the astronomical spectrum of the dust in BD+20803 (Fig.1, dashed line). The dust in this ~300 My old main sequence star probably was formed by the collision of planetesimals and is similar to IDPs in our solar system [5].

SU Aur [6] is an 8 My old pre-main sequence star in the Tauri phase. While the circumstellar disk in this stage is still gas-rich and relatively primordial, significant accretion of primitive bodies is already possible. The astronomical spectrum of this system (Fig.1, thin line) also shows a similarity to the spectrum of the Murchison matrix shocked at 34 GPa.

These results suggest that highly shock-processed, hydrated planetary materials, similar to CM2 chondrites, could be the source for circumstellar dust in several young solar systems. This also implies a similarity in the mineralogical composition of the materials in our early solar system and currently forming solar systems.

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