SIMULATION OF MICROMETEORITE IMPACTS THROUGH IN SITU DYNAMIC HEATING OF LUNAR SOILS.

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Introduction: Space weathering is driven by the interaction of surface materials on airless bodies with energetic particles from the solar wind and by micrometeorite impacts [1]. Such interactions result in changes to the microchemical and microstructural characteristics of soil grains and thus, spectral properties, making it difficult to characterize such surfaces remotely. In order to understand the formation and nature of space-weathering features, experiments that simulate solar wind irradiation, micrometeorite impact, or heating events were performed on a variety of target materials including GEMS, chondritic meteorites, and terrestrial analogs, e.g., [2-7]. While such static investigations provided insight into space-weathering characteristics, in situ experiments enable direct observation of chemical and structural changes that result from simulated space-weathering conditions in real-time. Here we present initial results on a dynamic heating experiment, performed inside a transmission electron microscope (TEM), to simulate a micrometeorite impact of lunar soils.

Samples and Methods: Grains of mature highland lunar soil 14259 were crushed, suspended in isopropanol, and drop cast onto carbon-coated grids for analysis in the TEM. We heated the samples incrementally inside a Philips CM200-FEG TEM at Arizona State University from room temperature to nearly 1000 ºC over the course of 15 minutes. We collected bright-field TEM images of the material at a variety of magnifications at roughly 150 ºC increments over the course of the experiment.

Results and Discussion: A select grain of interest, which included low concentrations of nanophase Fe (npFe) particles and irradiated rims, was chosen for continuous monitoring throughout the experiment. Between room temperature and 500 ºC we did not observe noticeable microstructural changes in this grain. Beginning at 500 ºC, where solar wind embedded H and He may become mobile [8], we observed changes in the size and distribution of Fe nanoparticles in the sample. The nanoparticle size increased significantly between 500-1000 ºC, with individual nanoparticles growing from 5 nm to as large at 40 nm. The nanoparticle concentration in the grain interiors also increased significantly with heating. We did not observe the development of vesiculated textures in this grain. We hypothesize that throughout the heating process Fe is diffusing from the surrounding matrix to coalesce into enlarged npFe grains. Additional heating experiments will determine whether this phenomenon is a broad trend or specific to this sample.

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