Solar Wind Proton Induced Hydroxylation on Lunar Soil 78421.38

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The DREAM2 (Dynamic Response of Environments at Asteroids, the Moon and moons of Mars) program is currently analyzing the effects of proton implantation and OH creation/retention in lunar soils and minerals as a function of temperature, defects and irradiation. The new beam line at NASA GSFC Radiation Effects Facility (REF) has been constructed and coupled to a UHV surface science chamber. For these analyses, lunar soils are compressed into a pellet, and exposed to a 2 keV H2+ beam to simulate solar wind irradiation. The exposure rates are varied from 10^{17} H+/cm^2 to 10^{19} H+/cm^2. Diffuse Reflectance Infrared Fourier Transform Spectroscopy (DRIFTS) is used to study the soils before and after irradiation. For the DRIFTS experiments, the samples are removed from the experimental vacuum chamber and placed in a Nicolet FTIR spectrometer to monitor the OH and water bands near 3 micron. Crushed fused silica was used as the control for the proton induced hydroxylation experiments. After an initial dose of $7.8 \pm 1.8\times10^{18}$ protons/cm^2, an irradiation time of 4 hours, a very sharp SiOH band centered at 2.74 microns is observed. For Apollo soil 78421, at a total flux of $3.1 \pm 0.7\times10^{18}$ ions/cm^2, a broad feature appears that is centered at 3.0 microns and ranging from 2.7 – 3.5 microns. When we compare the our proton induced hydroxylation experiment to Ichimura's 2012 experiment with a Apollo 16 highlands soil, 62241, and a Apollo 17 mare soil, 70051, there is surprisingly very little qualitative difference in the band shape from these dissimilar Apollo samples. Maybe this is not so surprising when considering that only 7 minerals are found in greater than 1% abundance on the Moon and only one (Ilmenite) does not consists of the structural silicon tetrahedral backbone. Unfortunately, the band broadening due to proton induced hydroxylation makes it impossible to distinguish between adsorbed water and OH using the 3 micron band alone. Temperature dependent measurements were performed following the irradiation experiment with a fresh sample of 78421 that had an initial and total proton flux of $3.0 \pm 0.7\times10^{19}$ H+/cm^2. The 78421 soil was heated to 398 K for ~5 min, the time needed to make the DRIFTS measurement, and was then allowed to cool naturally overnight. The 3 micron band intensity did not change during this thermal cycle. However, there appears to be more broadening from 3.1 out to 4.0 microns! This implies that the hydroxyls have diffused into the soil, and are likely located on higher energy defect sites that are also more constrained. The broadening of a vibrational frequency can reflect the presence of a double-well potential or a broadening of the Morse potential, Greathouse 2009. A quantitative assessment of the proton induced hydroxylation rates will be presented.