

DESORPTION OF ADSORBED WATER ON THE MOON BY PHOTONS AND IONS. Emily H. Mitchell, Micah J. Schaible, Daniele Fulvio, Catherine A. Dukes, and Raúl A. Baragiola, University of Virginia, Laboratory for Atomic and Surface Physics, Thornton Hall, Charlottesville, VA 22904. Emails: emma.mitchell@virginia.edu, ms5vf@virginia.edu, df6vz@virginia.edu, cdukes@virginia.edu, raul@virginia.edu

Introduction: Sunshine et al. [1] have observed a diurnal variation in the hydration of the lunar surface through the OH infrared absorption band, using the infrared spectrometer on board the Deep Impact spacecraft.

We postulate that the decrease in the surficial OH/water during the lunar day is due to photodesorption from solar photons and sputtering by the solar wind. In this study we examine, in the laboratory, the removal of monolayers of water adsorbed on minerals and lunar highland soil by 121.6 nm, 193 nm, and 253.7 nm ultraviolet photons, as well as by 1 keV/amu protons and He⁺⁺ ions.

Experimental: Samples of terrestrial olivine and anorthite, as well as lunar highland soil, are mounted at the center of an ultra-high vacuum chamber at a base pressure of 10⁻¹⁰ Torr. The samples are initially cleaned by a low-energy plasma [2], and then exposed to gaseous water from a capillary-array gas doser at room temperature to form a single water monolayer on the surfaces.

A Thermo-Nicolet FTIR spectrometer is used in reflectance to characterize the surface of the samples *in situ*, both before and after water dosing. Reflectance spectra are taken over the range 0.8 - 12 μm and we center our attention at the 3- μm OH stretch band to quantify the concentration of adsorbed water. The area of this absorption band gives the relative measure of water on the surface, after baseline subtraction. Long measurement times require subtraction of absorption by water condensed on the LN₂-cooled infrared detector [3].

Irradiations: The adsorbed water is exposed to 121.6 nm (Lyman- α) photons from a microwave hydrogen lamp at normal incidence. The lamp consists of a quartz tube coupled to a microwave power supply (Ophos MPG 4M) and connected to a gas manifold. It is filled with a gas mixture of 10% H₂ and 90% Ar to a pressure of 1.0 Torr. Photons enter the vacuum chamber through an MgF₂ window. An aluminum cylindrical mirror serves to collimate the light and align it directly toward the sample [4].

The photon flux is measured via an in-line photodetector, which is a thin Al wire mounted at the end of the collimating cylinder, calibrated against a photodiode standard traceable to NIST.

The hydrogen lamp is run at fluxes between 5 x 10¹³ and 10¹⁵ photons cm⁻² s⁻¹ until the desired fluence is reached, while the water remaining on the surface is analyzed using reflectance FTIR as a function of irradiation fluence. The decreases in the ratio of the OH absorption band area after irradiation to before irradiation give a quantitative indication of the amount of water desorbed. By monitoring the sample at a variety of fluences with subsequent FTIR measurements, we can calculate the photodesorption yield in terms of desorbed molecules per incident photon, or the cross section by dividing by the surface density of the water monolayer.

In addition, we measure the photodesorption yield of water from olivine and anorthite for 253.7 nm photons from a Hg light source. Furthermore, the desorption yield of water adsorbed onto a C substrate mounted on a quartz crystal microbalance with a sub-monolayer sensitivity is measured as a function of irradiation fluence of 193 nm photons from an ArF excimer laser.

Sputtering of adsorbed water will be studied using the methods described for measuring the sputtering yield of adsorbed Na from mineral surfaces [5]. In these studies, we quantify the surface concentration of adsorbed water relative to silicon from the mineral lattice by X-ray photoelectron spectroscopy (XPS). These measurements are taken as a function of hydrogen and helium fluence to obtain a depletion cross section, which can be converted into coverage-dependent sputtering yields. In addition, ions ejected from the sample are detected with a secondary ion mass spectrometer (SIMS). These measurements are used in conjunction with XPS data to ascertain the physical processes involved in sputtering.

Results will be presented and discussed at the meeting. This research is supported by NSF Astronomy.

References: [1] Sunshine, J.M. et al (2009) *Science* 326, 565. [2] Dukes, C.A., Baragiola, R.A. (2009) *Surf. Interf. Anal.* 42, 40. [3] Burke, D.J. et al (2011) *Icarus* 211, 1082. [4] Westley, M.S. et al (1995) *Nature* 373, 405. [5] Dukes, C.D. et al. (2011) *Icarus*, in press.