

**PHOTODESORPTION OF ADSORBED WATER ON THE MOON.** Emily H. Mitchell, Micah J. Schaible, Ujjwal Raut, Daniele Fulvio, Catherine A. Dukes, and Raúl A. Baragiola, University of Virginia, Laboratory for Atomic and Surface Physics, Charlottesville, VA 22904. Emails: ehm4qb@virginia.edu, ms5vf@virginia.edu, ur5n@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. One possible cause for this variation is the photo-induced desorption of H<sub>2</sub>O/OH molecules during the lunar day and subsequent re-adsorption after nightfall when the temperature drops. In this study we examine the removal of adsorbed water from lunar highland soil by Lyman- $\alpha$  (121.6 nm) and 193 nm photons.

**Experimental:** The experiments were done using lunar soil sample 65901. A thin layer of soil was placed in a 10-mm-diameter copper cup and mounted in an ultra-high vacuum chamber held at a base pressure of  $\sim 10^{-9}$  Torr. Adventitious carbon and atmospheric water vapor were sputter-removed by 500 eV xenon ions. The sample was cooled to  $\sim 100$  K and then exposed to water vapor from a capillary-array gas doser. The presence of water on the surface was verified using an X-ray photoelectron spectrometer (XPS), which gives information about the atomic species present in the top several monolayers. The soil with adsorbed water is exposed to 121.6 nm (Lyman- $\alpha$ ) photons from a microwave-discharge hydrogen lamp (Ophos). The lamp consists of a quartz tube coupled to a microwave power supply and connected to a gas manifold. It is filled with a gas mixture of 10% H<sub>2</sub> and 90% Ar to a pressure of 1.0 Torr. Photons enter the vacuum chamber through an MgF<sub>2</sub> window. An aluminum tube is used to collimate the light, and a MgF<sub>2</sub> lens at the end of the tube focuses the light to a spot  $\sim 12$  mm in diameter, about the size of the copper cup used to hold the lunar soil. The photon flux is monitored via an in-line photodetector, a thin Al wire mounted at the end of the collimating cylinder, calibrated against a photodiode traceable to NIST. The hydrogen lamp is used to illuminate the lunar soil up to fluences of  $\sim 10^{17}$  to  $10^{18}$  photons cm<sup>-2</sup>.

**Results:** The changes in the surface composition after each step of photon irradiation is measured via XPS to quantify the loss of H<sub>2</sub>O/OH from the sample surface as a function of fluence. Previous works have investigated desorption of thick water films due to 121.6 nm photon irradiation [2], as well as desorption of a monolayer of water from a carbon-coated quartz crystal microbalance due to 193 nm photons from an

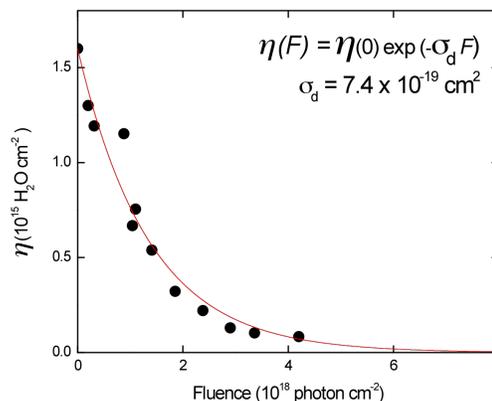


Fig. 1: Column density  $\eta$  of water ice adsorbed on a C substrate decreases exponentially with fluence  $F$  during irradiation by 193 nm photons at 120 K. The fit gives desorption cross-section  $\sigma_d$ , with  $\eta(0) = 1.6$  monolayers (1 monolayer =  $10^{15}$  H<sub>2</sub>O cm<sup>-2</sup>). From [3].

ArF excimer laser [3, Fig. 1]. Results of the current study, combined with the knowledge of the solar photon flux impinging the lunar surface, will yield lifetimes of H<sub>2</sub>O/OH species on the lunar regolith.

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**References:** [1] Sunshine, J.M. et al. (2009) *Science* 326, 565. [2] Westley, M.S. et al. (1995) *Nature* 373, 405. [3] Mitchell, E.H. et al. (2011), LPI Wet vs. Dry Moon.