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WHAT DOES LUNAR ICE LOOK LIKE? THE LUNAR REGOLITH ICE AND SUBLIMATION EXPERIMENT (LRISE)

Abstract

There is currently a surge of interest and increased activity by various nations and organizations as well as the private sector to engage in lunar exploration. The prospect of the availability of water on the Moon as a local resource would make human exploration efforts significantly easier and cheaper. However, a direct in-situ discovery of water ice on the Moon has yet to be made. A number of lunar rover missions are currently being developed around the world specifically for that purpose, to search for exact locations and understand the origin, quantity and condition of this water ice.

In this paper, we present our laboratory experiments to replicate the process of water vapor deposition and ice crystal formation on lunar regolith. We perform water vapor deposition in cryogenic vacuum onto small (1 cm^3) samples of currently available lunar regolith simulants like LHS-1 and LMS-1. The samples are cooled with LN2 down to 170K and a water vapor deposition system relying on microfluidic flow controllers is used to slowly grow ice crystals on the surface layer of the sample. The process takes place inside an ultra-high vacuum chamber at pressures of 10^{-7} mbar to approximate the thermal vacuum conditions of some permanently shadowed regions (PSRs) near the lunar poles. In order to simulate an investigation of PSRs with small lunar rovers, we observe the samples using macro lens photography with $5 - 30$ μm/pixel resolution under different lighting conditions. Lastly, we direct a low power laser on the samples to measure the minimum power needed to vaporize ice and investigate the possibility of detection by looking at before and after images. Our laboratory investigations can be used to constrain the minimum instrumentation needed for secure detection of surface water crystals in small PSRS using future small robotic rover missions.