Development of frosting system for lunar simulant and the detectability of ice growing on the simulant by NIR measurement

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In recent years, many remote sensing studies have suggested the existence of lunar water, but it is still an open issue how or how much water is on the Moon. Lunar prospector launched in 1998 found the concentration of proton around lunar poles. In 2009 Lunar Crater Observation and Sensing Satellite (LCROSS) project observed ejecting debris from Cabeus crater and estimated that concentration of water ice is 5.6±2.9 wt%. Chandrayaan-1 data suggested the abundance of water could be as high as 0.077wt%. After these results, Japan’ s space agency JAXA and India’ s space agency ISRO have signed an Implementation Arrangement (IA) for a Joint Lunar Polar Expedition in December 2017. In preparation for this mission, assuming that the grains of lunar regolith are covered by water frost on the lunar permanently shadowed regions, we made minute ice on lunar simulants and measured their Near-Infrared reflectance spectra. As lunar simulant we use olivine (from San Carlos, 125-250um, Fo90) and lunar simulant FJS-1 (Shimizu Corporation). We developed a frosting system. It’ s a kind of cooling stage in which simulant grains cooled with liquid N2 can be mixed with highly humid air and vibrated. In the stage, water frosts condensed and cover the surface of grains. The top of the stage is covered with silica glass plate, so we can observe the spectra without taking out samples from the stage. We observed the reflectance spectra of the frosted simulants with a Near-Infrared imaging spectrometer developed by Saiki at 950-1600 nm, angle of incidence = 30˚, angle of viewing = 0˚. After the measurement, we weighed the mass of frosts. In order to prevent additional frost during weighing, we made a vinyl house and weighed frosted samples in the house purged with dry N2 gas. Then, the samples were heated and the frosts on them evaporated. After heating we weighed the samples again, regarded the decreased mass as the mass of frosts, and calculated mass fraction of frosts. We succeeded in making the minute ice less than 1wt% on the simulant, but it is difficult to make ice homogeneously and to control the amount. In order to address these problems, we developed a new fall-type frosting system. In this system cooled simulant fall down in humid air and covered by minute ice homogeneously.We continue trial and error on falling distance and humid air volume aiming to control the amount of frost on the order of 0.1 wt%. Latest results will be reported.

Keywords: Lunar polar mission, frosting experiment

