

Preliminary Results from the Polar Ice Capture Experiment. B. M. Compton¹, D. L. Linne², and A. J. Ring³,
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Abstract: In-Situ Resource Utilization (ISRU) is an essential topic of interest for efficient travel in space. Water is of particular interest since its discovery in the permanently shadowed regions (PSRs) of the Moon. It is bound in the regolith in the form of ice, so one approach is to heat the regolith to sublimation temperatures and capture the water at a low pressure. Once it is stored as ice and transported to a sunlit ridge, it can then be electrolyzed. The resulting oxygen and hydrogen can then be used for life support or rocket propellant. However, this water production process requires a thorough understanding of frost production in low pressure and low temperature.

A diffusion-limited aggregation (DLA) approach is used to model the changing frost growth with time under varying conditions. This DLA approach is also manipulated to create different porosities which results in different bulk densities. The model predicts frost thickness and heat flux with time given the mass flow rate.

An experiment was designed to validate this model using a horizontal flat plate and low temperatures and pressures. The cold plate temperatures vary from 240 to 268 K and the pressures are 100 and 500 Pa. The pressures set the sublimation temperature of water and therefore the temperature differential of the frost layer. The frost layer thickness, mass, and heat flux are measured with time. The density is calculated using the plate surface area, mass, and thickness of the frost. The frost growth rate is calculated using the thickness measurement with time. To simulate the time needed to capture the water at a scaled flow rate, tests are run for multiple days.

This presentation will cover the results of the experiment and the verification of the frost growth model. Preliminary results suggest good agreement with the frost growth model. The frost thickness and heat flux predictions are within margin after the density measurement is added to the model. Repeat tests were performed at each condition to increase the confidence level in the results.