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ASSESSING THE EFFICACY OF THE STANDING WAVE ELECTRIC CURTAIN IN CLEARING DUST FROM A LUNAR ROVER RADIATOR

Abstract

The moon's surface is covered with regolith, a thin grey powder mostly composed of Silicon dioxide. This dust may be electrostatically charged due to interactions with the solar wind and can adhere to spacecraft surfaces such as radiators and solar panels, negatively impacting their performance and mission success. Many methods have been studied to remove these charged dust particles from spacecraft surfaces, including the standing wave electric curtain. However, replicating the effect of charged lunar dust particles on earth has been a challenge for properly characterizing the performance of such devices. In this work, we present simulations and experimental results to validate the design of a Standing Wave Electric Curtain used to remove lunar dust from the PEEKbot rover's radiators.

Unlike a previous study which used ferromagnetic particles to test this curtain, we will use charged lunar simulant particles to create a more realistic representation of the lunar environment. In past studies, lunar regolith simulants were charged using triboelectric effects. This method works, but controlling the amount of charge transferred is difficult. In this paper, in addition to triboelectric charging using a Van De Graaff Generator or simple nylon brushes, we propose and test a novel approach for charging the regolith which to our knowledge has not been attempted in the past with regolith simulant: exposure to plasma created by corona discharge in a controlled environment and charge measurement using an electrometer.

We will complement the results of the experiments above with a simple analytical model of the curtain's effects, and numerical simulations performed in COMSOL that characterize the dust removal efficacy and the impact of the dust presence on heat transfer properties of the radiator. After validating our analytical and computational model against the experiments, we use these models to assess whether the electric curtain would behave appropriately on the lunar surface considering the lack of an atmosphere and different gravitational acceleration. We will also assess how the parameters such as the voltage and power needed to operate the curtain change when going from earth conditions to lunar conditions.