CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)

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Project Number

38664

Project Title

Investigating Charging and Electrostatic Discharge Risks for Astronauts on the Lunar Surface

Abstract

Objectives/Goals

The Moon is devoid of a global magnetic field and is directly exposed to space plasma and solar radiation, causing the surface and any objects on it to be charged by collection of ions and electrons from the plasma. Lunar dust is easily levitated, and dust deposition onto spacesuit and spacecraft surfaces was reported as a significant problem during the Apollo mission. Dust deposition creates non-uniform surface conductivity and results in differential surface charging. The objective of this study is to investigate whether electrostatic discharge will be a significant threat to astronauts and spacecraft during future space exploration at the lunar terminator.

Methods/Materials

An experiment was designed to study discharge on dusty spacesuit and spacecraft. In a vacuum chamber, two different sample plates were tested in a plasma (with properties similar to average solar wind conditions) generated by an electron bombardment gridded ion thruster. The first sample plate, consisting of an aluminum plate with Kapton tape at the edges, was used to simulate discharge on a typical spacecraft surface. The second sample plate, consisting of an aluminum plate with spacesuit material GoreTex at the edges, was used to simulate discharge on spacesuit. Three different test setups, ranging from a clean, dustless surface to a dusty surface covered by JSC-1A lunar regolith were considered.

Results

While clean surfaces under the test conditions are generally resistant to discharge, significant electrostatic discharge and arcing were observed for the dusty surfaces. Large biasing potential and more dust coverage both resulted in higher discharge rates. We also find that dust deposition both enhances differential charging, a necessary condition for discharge; and increases the number of triple-junction interface points between plasma, conductor and dielectric material, where discharge is triggered. Discharge occurs more frequently on "dirtier", high voltage surfaces in plasma.

Conclusions/Discussion

This research presents the first reported laboratory experiments on electrostatic discharge on dusty spacesuit/spacecraft surface in a simulated lunar plasma environment. The investigation suggests that because of the combined condition of dust coverage and high voltage charging at the lunar terminator, electrostatic discharge will pose as a serious risk to astronauts and equipment in future lunar missions in that region.

Summary Statement

I was able to utilize experimental results to determine that the lunar plasma charging environment will pose as a significant threat to astronauts in the lunar terminator region.

Help Received

William Yu from University of Southern California aided in experimental equipment understanding and enforcing proper safety procedures when operating lab equipment.