Student-designed mission patches for the Weiss, Wolverine, and Wolfpack CubeSat Development Teams and the AMARIS Lunar Rover Team.

Mitigating Lunar Dust on Spacecraft Surfaces Using Electromagnetic Fields

The Wolverine and Wolfpack CubeSat Development Teams
Middle and High School Students, Palm Beach Gardens, Florida
Michael Mikati, Owen Welch, and Caeden Dooner,
Educators: Shawna Christenson and Kevin Simmons *Correspondence: ksimmons@bluecubesat.com

Background image courtesy of ShutterStock

Team AMARIS Objectives

To apply knowledge gained expand through 2 CSLI missions: WeissSat-1 and CapSat-1 to build a CubeSat-based lunar rover.

To better understand ionized lunar dust behavior and address its adhesion to solar panels using Exolith Lunar Highland Simulant.

Mission: To evaluate the efficiency of electric and magnetic fields in mitigating dust accumulation on solar panels on the lunar surface

Lunar Regolith is primarily composed of abrasive and fine (<250 µm) particles; formed through repeated micrometeorite collisions with the lunar surface. They cling to equipment & electronics and shorten material lifetimes and reduces efficacy. They are toxic when inhaled and can damage spacesuits and essential equipment.

WCDT/AMARIS Background

2015
- Wolverine CubeSat Team (WCDT) founded
- Nine original members
- First tethered and High Altitude Balloon (HAB) missions with telemetry

2016 - 2017
- Submission to CubeSat Launch Initiative (CSLI)
- Mission: examine in LEO extremophile bacteria
- NASA CSLI - 2017 selection

2018
- 2nd successful HAB launch
- WeissSat-1 successfully integrated, tested, and was launched by Dec. 3rd, 2018

2019
- NASA CSLI – 2019 selection (for 2nd CubeSat)
- AMARIS Team Formed

2020
- WeissSat-1 Final Report submitted to NASA
- Formation of the Wolfpack CubeSat Development Team – working with Nebraska and N. Carolina for CSLI 2020 submissions


WeissSat-1


Image Courtesy of SpaceX


High Altitude Balloon Launch


Image of Student-Built Lexan Dust Box


Van de Graaff Generator
Image Courtesy of Arbor Scientific


Image Courtesy of NASA

Theory

- Ionized Lunar dust should be repelled by positively charged equipment (Coulomb's Law)
- ITO(Indium Tin Oxide) plates are clear conductors that can create a positively charged surface
- Van de Graaff Generator could be used to ionize simulant


Van de Graaff Generator Ionizing Dust Simulant


ITO Plate


Equations for Electrical Forces
Images courtesy khanacademy.com

Experimentation

- Initially tested change in solar panel output when ITO plates are attached
- Regolith simulant placed in container and ionized by a Van de Graaff generator
- ITO plates inserted and charged by DC generator
- Measure the amount of dust that had been repelled across a certain point in the container


Dust Simulant Before Ionization


ITO Plate Testing


DC Power Generator


Magnified Image of Lunar Dust


UCF Lunar Highlander Dust Simulant


Cutting ITO Plates

Results

- Minimum V drop (~2%) in solar panels when using ITO panels vs. without
- Van de Graaff generator affected particle velocity
- Inconclusive results during ITO plate testing
- Experimentation is still in progress

DC Power Supply Voltage to ITO plates	Volts measured between ITO plates (Acm)
5V	4.9V
10V	9.8V
15V	12.6V
20V	19.8V
25V	24.7V
30V	29.9V

Result of ITO Plate Voltage Testing


Image Courtesy of Astrobotic

AMARIS Lunar Rover

- Utilize CubeSat-based technology for all subsystems except propulsion
- Complete more tests with revised equipment and methods
- Once testing is complete compile a materials list for construction of the rover
- Achieve complete rover construction by 2022
- Recent collaboration with Astrobotic has been to land on the moon in a Peregrine Lander
- Design, build, test, and launch a rover onto the moon


Deployment of AMARIS Solar Panels (Images Courtesy of Julian Lupyan)