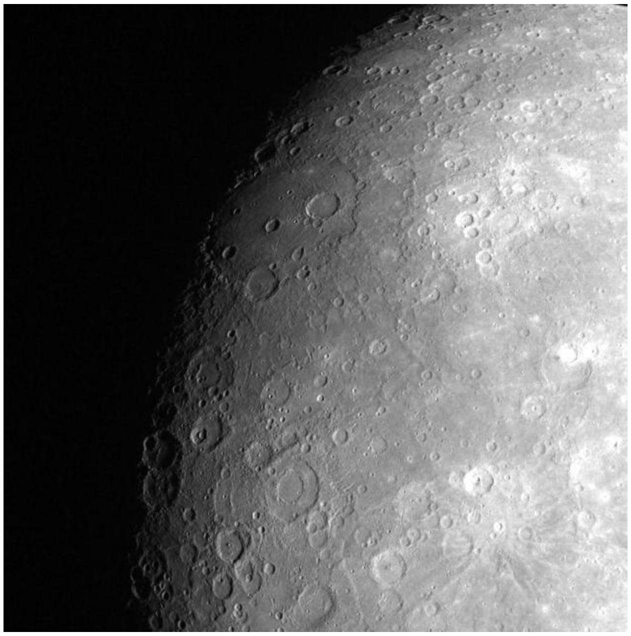
Dust Busters



Name of Technology:
Surface Dust Mitigation via Active and Passive Technologies

Participating NASA Centers:
KSC (Lead); JSC, LaRC

Technological Area:
Z13.01 Active and Passive Dust Mitigation Surfaces

Vision for the Technology:
Past lunar missions have proven that dust from the surface is a critical issue that requires solutions for longer term missions. Lunar dust is sharp and acts like a "black body" preventing thermal radiators from releasing heat. Active and passive dust removal technologies are needed to prevent the accumulation of dust which can have detrimental effects on important surfaces. Examples of surfaces are control panels, displays, space suits, thermal radiators, solar panels, batteries, mechanical systems, hinges, etc.

Challenges:
Both active and passive dust mitigation technologies have challenges in this environment. Active technologies consist of using either electricity/electrostatic charges or mechanical brushes and blowers. For example, high electrical technologies may damage other sensitive equipment due to grounding and/or discharge issues. Furthermore, mechanical brushes may scratch critical surfaces effecting the function of that system.

Passive technologies may consist of materials and/or surface coatings to reject dust. Materials and coatings may work in one situation, but not in others. Silicone has been shown to reduce dust from adhesion, however, if the dust becomes embedded into the material due to its sharp structure it becomes damaging to the sensitive surfaces.

NASA Seeks to Meet the Following Specs:

Success will be measured by demonstration of a scalable technology that exhibits:

1. a dramatic reduction of greater than 90% relative to a reference material surface (minimum of 50%)
2. articulate adhesion for micro-particles, specifically those described as Lunar dust simulant, with diameters less than 50 micrometers

Overview of Student Project:
NASA seeks innovative technologies that use unique methods to keep vital surfaces (i.e. solar panels, electronics, mechanisms, spacesuits, spacecraft, etc.) clean from dust on the moon and Mars. It is highly desirable that the technologies have very little or no involvement by astronauts. In addition, the technologies cannot interfere with the function of the surface to be cleaned.

Innovative Areas Student Projects Can Address:
A. Active Dust Mitigation Technologies

- Brushing: A self-cleaning brush to mechanically remove dust from surfaces. The brush can be mechanically operated using power or can be temperature activated, such as shape memory alloys.
- Electrostatic removal: Methods to use direct-current (DC) electric fields to remove

dust from surfaces, either internal to the surface (embedded) or external using a removed high-voltage source.

- Vacuum: Methods to remove particles from surfaces using suction of gases.
- Jets: High-velocity gas jet that blows dust particles from surfaces.
- Spinning surfaces: Surface rotates in a manner that does not allow collection of dust on it.
- Vibrational surfaces: Vibrating surface bounces the particles from the surface.
- Electrodynamic removal: The surface contains embedded electrodes with varying high-voltage signals applied to lift and transport dust off the surface.

B. Passive Dust Mitigation Technologies

- Electrostatic discharge (ESD) coatings and films: Statically dissipative coatings are less likely to accumulate charge, and hence dust, in dry environments.
- Superhydrophobic coatings: Materials with a very high contact angle can lower the adhesion of water-based contaminants, not allowing the capillary forces to take hold.
- EVA- and robotic-compatible dustproof electrical, fluid, and gas connectors.
- Lotus leaf coating: Microscopic nanostructures used to limit the van der Waals force of adhesion.
- Peel-away coating: Removable surface coatings.
- Gradient surfaces that direct dust adhesion away from vital surfaces.

Project Phases

I. Analytical and experimental proof-of-concept of critical function and/or characteristics.

II. Component and/or breadboard validation in a laboratory environment.

Research Funded by NASA on this Topic:

Proposal Number: 20-1- Z13.01-6344
Integrated Approach for Space Active and Passive Dust Mitigation Enabled by Electroactive Polymer Technology

Proposal Number: 21-2- Z13.03-2204
xEMU Lunar Dust Mitigation Devices

Proposal Number: 20-1- Z13.01-5784
Solar Array Coatings for Mitigating Lunar and Martian Dust

Proposal Number: 09-2 X6.02-8804
Nanotube Electrodes for Dust Mitigation

Proposal Number: 08-1 X5.02-9458
Dust Mitigation for the Lunar Surface

Proposal Number: 08-1 X5.02-8794
Liquid Crystal Membrane Dust Mitigation System for Lunar or Martian Operations

Proposal Number: 21-1- Z13.02-1328
Surface micro-texturing of advanced bearing materials for lunar dust mitigation

Proposal Number: 22-1- S16.05-1989
Novel Coating Concepts for Lunar Regolith Dust Mitigation for Thermal Radiators and Extreme Environments

Proposal Number: 22-1- H3.09-1562
Vortex Dust Removing Attachment

References:

Z13.01 Active and Passive Dust Mitigation Surfaces

X5.02 Surface System Dust Mitigation

X6.02 Surface System Dust Mitigation

X7.04 Surface System Dust Mitigation

NASA's Coating Technology Could Help Resolve Lunar Dust Challenge