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Development of the Electrostatic Precipitator (ESP) for Mars and Electrodynamic Dust Shield (EDS)

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Kennedy Space Center's Swamp Works is a fast-paced and diverse technology development laboratory that aims to advance commercial and government capabilities to colonize extraterrestrial environments. As a part of Swamp Works, the Electrostatic and Surface Physics Laboratory (ESPL) is currently developing new technologies that will further NASA's capabilities to colonize lunar and Martian environments. At the ESPL, the objective of the overall project is to aid in the dust mitigation of robotic and human exploration missions to the moon and Mars.

The moon and Mars are covered with layers of dust, which can make long-term exploration missions very difficult. The team at the ESPL is developing an electrostatic precipitator (ESP) to aid in the reduction of interference from airborne Martian dust on equipment. The ESP is designed to mitigate the dust in an intake of CO2-rich dusty gas (i.e., the Martian atmosphere). The ESP is essentially a cylindrical tube with a coaxial wire electrode. Applying a high voltage through this electrode induces a corona discharge (a glowing plasma that envelops the electrode), which is used to charge the inflowing dust. The electric field caused by the corona pushes the charged dust to the walls of the precipitator, preventing the dust to flow out of the tube.

Environmental dust can make long-term exploration missions very difficult, and settled dust is no exception. Settled lunar or Martian dust can hinder the performance and lifetime of equipment. For example, dust can settle on the solar panels of a lunar or Martian rover, decreasing its performance while increasing its charging time. To address this, the team at the ESPL is also developing an electrodynamic dust shield (EDS), which is designed to remove lunar or Martian dust from the surfaces of equipment. The EDS uses a non-uniform electric field to generate a dielectrophoretic force, which pushes the particles away from the surface of the shield. A number of dust shields will be tested on the exterior of the International Space Station (ISS) via MISSE-11, a flight payload to the ISS that will test the effects of long-term exposure to space on materials.

During my internship at the ESPL, I aided in the development of these technologies. For the ESP, I helped characterize the electrical properties of various geometries and helped redesign the hardware of the testbed (the precipitator used to test this technology in the lab). To characterize the electrical properties of the ESP, I ran various tests of the precipitator, which consisted of varying the environmental conditions and geometry of the testbed. Analyzing the electrical properties of the ESP in various environmental conditions is necessary to characterize its collection efficiency, since it will be used in the dusty Martian environment.

For the EDS, I helped analyze the dielectric strength of the surface of the shield via high-voltage testing. A dielectrically strong surface will help the shield survive the harsh environment of space, which will enable it to have both lunar and Martian applications.