DUST IN SPACE

Over the next decades, NASA will continue to send robotic probes to explore the solar system. These robotic explorers will attempt to find answers to scientific questions, demonstrate new technologies, identify resources, and send back critical data and images.

The moon and Mars offer difficult challenges to this ambitious plan of exploration. One of the most important problems is the dust, which causes hardware failures and obstruction to camera lenses, thermal radiators and solar panels, and also poses a hazard to human health. Breakthrough technologies must be developed to solve this problem, and the electrodynamic dust shield is one of them.

THE MOON

The lunar regolith, or soil, consists mainly of a powder that is abrasive and clings stubbornly to surfaces such as solar panels, viewports and extravehicular activity suits. During Apollo missions, three days of exposure to the lunar environment rendered some spacesuit joints unusable. The primary mechanism for dust adhesion on the moon is believed to be due to electrostatic forces.
MARS
Frequent dust devils and occasional dust storms reaching global proportions loft dust from the surface of Mars into the low-pressure atmosphere. The fine particles can stay suspended for long periods of time. The collision of these windblown dust particles in the atmosphere with stationary surface particles may cause the surface of Mars to become electrostatically charged. Soil and dust particles also may acquire a charge due to incident ultraviolet radiation flux reaching the surfaces.

ELECTRODYNAMIC DUST SHIELD
The electrodynamic dust shield technology being developed at Kennedy is based on the electric curtain concept introduced by F.B. Tatom and collaborators at NASA in 1967 and further developed by researchers at the University of Tokyo in the 1970s. This technique has been shown to lift and transport particles using dielectrophoretic forces. The technology has never been applied to space applications on the moon. The electric curtain consists of a series of electrodes connected to a multiphase alternating current source. The source generates a travelling electric field wave that carries dust particles along.

Several electrodynamic dust shield prototypes that remove dust from surfaces and that prevent further accumulation have been developed. Transparent dust shields with transparent indium tin oxide electrodes on a transparent substrate can prevent dust buildup on camera lenses, spectrometers and other optical systems, as well as viewports, visors, solar panels and thermal radiators. Opaque dust shields can protect mechanical and electrical connectors, batteries and seals. Flexible dust shields with carbon nanotube electrodes on fabric can prevent dust accumulation on spacesuits.

The Kennedy Space Center’s electrodynamic dust shield prototypes have been extensively tested in the laboratory at high-vacuum conditions and aboard NASA's Reduced Gravity Flight aircraft at high-vacuum and simulated lunar gravity conditions. Currently, a flight unit is under development for testing on the International Space Station where it can be exposed to the extreme environment of space.