LUNAR SURFACE CLEANING ROBOTIC UNIT WITH ELECTRON BEAM [SCRUB].

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Introduction: Lunar regolith presents a critical and mission-limiting challenge for Lunar surface systems. Debriefs from the Apollo missions revealed that accumulation of fine lunar dust adversely affected a wide range of systems, including instrumentation, mobility hardware, thermal control surfaces, optical elements and extravehicular activity (EVA) systems, underscoring the need for advancements in lunar dust removal technology in order to support longer EVAs on future missions [1].

Unlike terrestrial dust, lunar regolith is highly abrasive and adheres tenaciously to surfaces, causing wear and tear on mechanical equipment and degradation of optical properties. The absence of weathering processes on the Moon results in sharp-edged particles that are particularly damaging to seals, joints, and moving parts.

In addition to angular particle geometry, charging from electrostatic forces causes it to cling stubbornly to surfaces. Finer dust particles (<20 microns) exhibit stronger adhesive and electrostatic forces, increasing the risk to robotics and humans [2]. Mechanical methods, such as nylon bristle brushes, have been used on the Moon but were found to be ineffective against fine grained particles [1].

Study: Orbital Mining Corporation (OMC) and Space Dust Research & Technologies (SDRT) will develop a robotic, non-contact cleaning apparatus tailored for removing Lunar regolith from solar panels using an electron beam or [Lunar Surface Cleaning Robotic unit with Electron Beam]. The project aims to advance Electron-Beam Dust Mitigation (EBDM) technology toward NASA TRL 5, by testing in lunar-analogous vacuum, thermal, and dusty conditions.

Experimental validation will be conducted using lunar regolith simulant in a vacuum environment representative of lunar surface conditions. Performance metrics will include dust removal and capture efficiency, repeatability, and power consumption, with particular attention given to fine particles that challenge conventional mechanical cleaning methods.

The results of this research will be presented at the Space Resources Roundtable at the Center for Space Resources at the Colorado School of Mines in June 2026.

References:

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