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# MAGNETIC CLEANING AND BENEFICIATION OF LUNAR REGOLITH

**Abstract**

Lunar Regolith, a particulate material that covers the surface of the Moon, is a valuable sample for obtaining insights into planetary science and a precious resource for long-term lunar explorations. However, it also poses significant challenges in both manned and unmanned explorations due to dust deposition on spacesuits and devices. This issue leads to the degradation and malfunction of exploration equipment, compelling the development of cleaning technologies used in the lunar environment. In this study, we focus on a unique magnetic cleaning system that employs a multipole permanent magnet-roll and a non-magnetic rotating sleeve. The cleaning mechanism has been utilized for manipulating toner particles in a laser printer, which can continuously capture, transport, and release the magnetic particles. When the device comes close to deposited regolith particles, the permanent magnet-roll attracts particles to the sleeve. The sleeve can rotate freely since it's non-magnetic, transporting the particles on the surface. At one area, the unique magnet-roll generates repulsive magnetic force, releasing the particles. Astronauts can apply this device for space use as a handheld device to clean particles by pushing and pulling it on their spacesuits and equipment without power consumption. Although a preliminary cleaning test of this device has been successful, a further understanding of the effects of the various parameters, such as rotational speed and magnetic-field strength, on particle dynamics is quite important, and the achieved insights can be utilized for other magnetic applications of regolith handling. Therefore, we developed an experimental setup that allows each parameter to be adjusted individually and investigated their effects on dynamics of regolith simulant particles, which were sieved into various sizes. The force balance applied to particles in each size range was calculated under various conditions, and the calculated results were in good agreement with the corresponding experimental results. The experimental results showed that the device could remove most of the simulant particles effectively in the optimal conditions. Moreover, the device has a potential to conduct beneficiation of regolith particles to achieve specific particles which contain aimed components for resource utilization processes on the Moon. The effects of particle permeability on the particle motions were also investigated, and it was verified that the device can also be used for beneficiation of particles. These findings highlight the potential of our magnetic cleaning system as an effective solution for mitigation and utilization of the regolith in long-term lunar explorations.