

ELECTROSTATIC CLEANER OF LUNAR DUST ON SOLAR PANEL AND OPTICAL LENS. H. Kawamoto¹ and M. Uchiyama, ¹Dept. of Applied Mechanics and Aerospace Engineering, Waseda University, 3-4-1, Okubo, Shinjuku, Tokyo 169-8555, kawa@waseda.jp.

Introduction: Because a cleaning system of lunar dust on the solar panel and optical lens is of great importance for the lunar exploration, we are developing a self-cleaning device of lunar dust utilizing electrostatic force.[1]-[4] Although it has been demonstrated that particles can be transported by the traveling-wave electric field formed by the parallel electrodes, some specific issues must be overcome to utilize this system for the lunar exploration. In this study, we have developed the electrostatic cleaner system that can be used in the lunar environment.

System Configuration: The developed cleaner system is shown in Fig. 1. The conveyor consists of transparent ITO electrodes printed on a glass substrate. The surface of the conveyor is covered with an insulating film to prevent from electrical breakdown between electrodes.

Traveling-wave propagation was achieved utilizing a set of positive and negative amplifiers controlled by a microcomputer. Four-phase rectangular voltage was applied to electrodes because it was most efficient compared to the sine or triangular wave. The power system is designed simple, small, and lightweight for the space application.

Lunar soil simulant FJS-1 (Shimiz Corp.) and JSC-1A (PLANET LLC.) were used for experiments.

Results and Discussion: The cleaning rate of more than 90% was realized with this system under conditions of 700 V voltage and less than 100 Hz frequency. The reduced transmission efficiency of light and the reduced generation efficiency of the solar cell after cleaning were both only several %. Figure 2 shows photograph of the demonstration. Although some fraction of large particles larger than 0.5 mm were not transported, they were cleaned by the application of

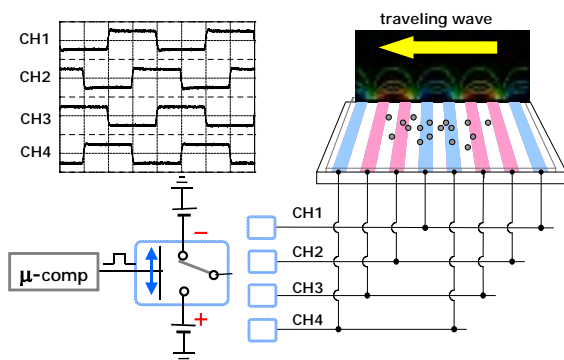


Figure 1: Electrostatic dust cleaner system.

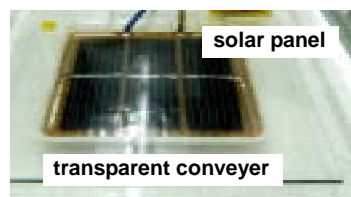


Figure 2: Operation of the electrostatic cleaner system

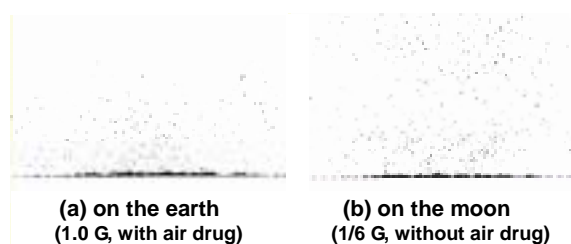


Figure 3: Calculated performance of the cleaner.

the ultrasonic vibration. However, very small particles adhered mainly on the electrodes, probably due to the image force, and they were not transported even though the ultrasonic vibration was applied. Cleaning of small particles, less than 1 μm , is the next challenge.

Because it is assumed that the lunar dust is charged by the irradiation of the solar wind and the cosmic ray, it was investigated whether initially charged particles can be cleaned efficiently with this system. Particles were mounted on the conveyor and then charged by utilizing the positive and negative corona discharges generated at the tip of the pin electrode settled on the upper side of the conveyor. The cleaning rates with positively charged particles ($+0.6 \mu\text{C/g}$) and negatively charged particles ($-0.6 \mu\text{C/g}$) were almost the same to the rate without charge.

The operation in vacuum was demonstrated and it was confirmed that the cleaning rate is increased in vacuum. The reduced gravity will be also of advantage on the moon as predicted by the numerical calculation. Figure 2 shows the cleaner performances calculated by the hard-sphere model of the Distinct Element Method.

The power consumption of this system was measured and it was estimated that it takes only 0.04 Wh for once operation of a 1 m^2 conveyor.

References: [1] Kawamoto H and Hasegawa N (2004) *J. Imaging Sci. Technol.*, 48, 404-411. [2] H. Kawamoto H, Seki K and Kuromiya N (2006) *J. Phys. D: Appl. Phys.*, 39, 1249-1256. [3] Kawamoto H (2008) *J. Electrostatics*, 66, 220-228. [4] Kawamoto H (2008) *STAIF-2008*, 203-212.