MITIGATION OF LUNAR DUST ADHERED TO MECHANICAL PARTS OF EQUIPMENTS USED FOR LUNAR EXPLORATION. H. Kawamoto[1] and T. Miwa[1], [1]Dept. of Applied Mechanics and Aerospace Engineering, Waseda University, 3-4-1, Okubo, Shinjuku, Tokyo 169-8555, Japan, kawa@waseda.jp

Introduction: The lunar surface is covered by a regolith (soil) layer; approximately 20% of this material by volume consists of particles less than 20 μm in diameter. Because of its small size and the low gravity, lunar dust is easily lofted when any disturbance occurs. The airborne dust might adhere to mechanical parts of equipment and get into bearings and seals; such a situation could lead to catastrophic damage. To overcome this problem, we have developed a barrier system that employs an electrostatic field to flick out and remove the lunar dust from the surface of mechanical parts.

System Configuration: A two-phase rectangular voltage is applied to the parallel electrodes printed on a plastic substrate in order to flick out the lunar dust on the flicker plate. The setup is shown in Fig. 1. Because a traveling wave is not generated by the application of two-phase voltage, particles are not displaced in one direction but are flicked out from the plate. An alternating electrostatic field acts as a barrier against the dust. Particles less than 60 μm in diameter were sieved from lunar dust stimulant FJS-1 for these experiments.

Results and Discussion: While several conventional techniques are available for the removal of large particles, removal of small particles is difficult. The flicker plate was inclined at an angle of 40 degree, and small dust particles were placed on it. Two-phase rectangular voltage was applied to the parallel electrodes printed on the flicker substrate, and the particles flicked onto the floor were weighed in order to determine the separation rate.

The determined separation rate, i.e., the ratio of removed dust to initial dust amounts, with respect to applied voltage and frequency is shown in Figs. 1 and 2, respectively. Dust on the flicker plate was removed at a threshold voltage of 0.4 kV. The separation rate increased with an increase in applied voltage up to 1.2 kV, but remained constant at voltages above 1.2 kV. On the other hand, the separation rate was almost independent of the frequency up to 100 Hz.

The observed separation rate was less than 70%. However, an investigation of electrostatic transport by means of the traveling wave revealed that system performance can be improved by applying ultrasonic vibration.[1] Numerical calculations using a 3D distinct element method[2] estimated that performance would further improve in the low gravity and vacuum environment on the Moon.

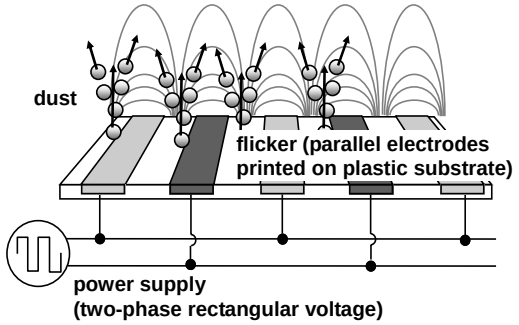

Figure 1: Electrostatic lunar dust flicker.

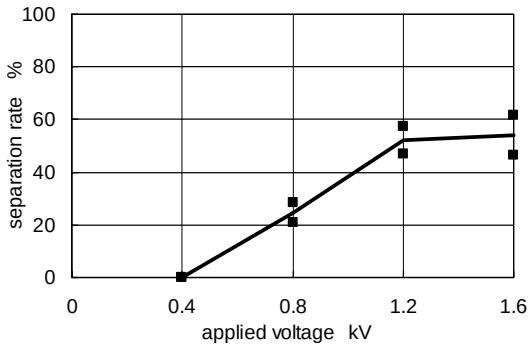

Figure 2: Separation rate with respect to applied voltage.

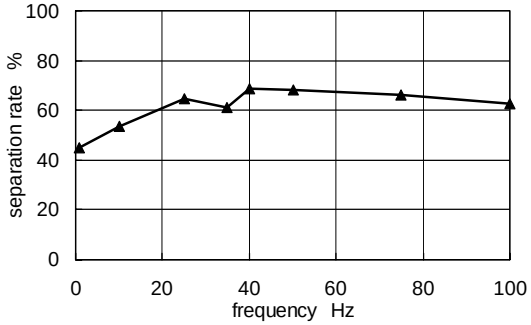

Figure 3: Separation rate with respect to frequency.

References: [1] Kawamoto H, Uchiyama M, Cooper L and McKay D S (submitted) J. Aerospace Eng., [2] Kawamoto H, Seki K and Kuromiya N. (2006) J. Phys. D: Appl. Phys., 39, 1249-1256.