ELECTROMAGNETIC CLEANER OF LUNAR DUST ADHERED TO SPACESUIT. H. Kawamoto,[1] H. Inoue and Y. Abe, [1]Dept. of Applied Mechanics and Aerospace Engineering, Waseda University, 3-4-1, Okubo, Shinjuku, Tokyo 169-8555, kawa@waseda.jp.

Introduction: Cleaning of lunar dust adhered to spacesuits of astronauts is of critical importance for the long-term lunar exploration. We are developing some kinds of conventional cleaning devices utilizing electrostatic and magnetic forces. Although electrostatic method is potentially the most versatile technique, we have started the development of the magnetic cleaning device based on the fact that some fraction of the lunar dust is magnetic.

System Configuration: Figure 1 shows a conceptual drawing of a continuous electromagnetic cleaner of lunar dust. It consists of a shaft made of non-magnetic material, stationary multi-pole magnetic roller, rotating sleeve, plate magnet, and collection bag. Magnetic particles in the lunar dust are attracted to the stationary magnetic roller, and by the magnetic and friction forces, they are transported around by the rotating sleeve. The magnetic roller is designed so that repulsive force is applied to the particle at a certain position (arrowed). When particles are transported at this position, particles separate from the sleeve, attracted to the plate magnet faced to the repulsive position, and then gathered in the collecting bag that covers the plate magnet. The system has a merit that it is very simple and works without power consumption.

Results and Discussion: A key of this system is the design of magnetic roller that has the function of the particle release. The magnetic force $\boldsymbol{F}$ of the particle in the magnetic field $\boldsymbol{B}$ is given by the following expression under the assumption that the particle behaves as a magnetic dipole placed at the center of the magnetized particle and the magnetic interaction between particles is neglected.[1]

$$\boldsymbol{F} = \frac{4\pi}{\mu_0}\frac{\mu-1}{\mu+2}\frac{a^3}{8}(\boldsymbol{B}\cdot\nabla)\boldsymbol{B}. \qquad (1)$$

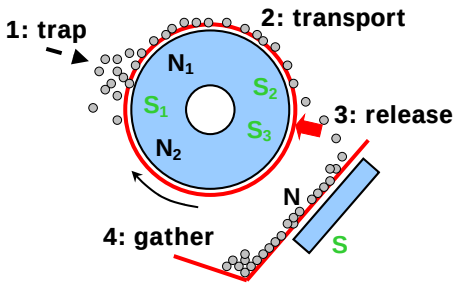

Figure 1: Concept of continuous electromagnetic cleaner of lunar dust.

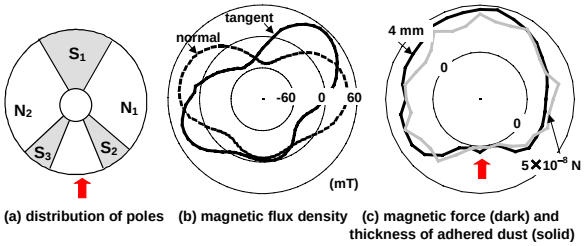

Figure 2: Circumferential distribution of magnetic flux density, magnetic force applied to magnetic particles, and thickness of adhered dust on the surface of the roller.

where μ_0 is the magnetic permeability of free space, μ is the relative permeability of particles, a is the diameter of the particle. Because the magnetic force is proportional to $(\boldsymbol{B}\cdot\nabla)\boldsymbol{B}$, the magnetic flux density $\boldsymbol{B}$ must be increased to the radial direction to realize the repulsive feature. This condition is realized by arranging the poles as shown in Fig. 2 (a). The magnetic roller, provided by Fuji Xerox, is originally designed and manufactured for the magnetic dual-component development system in electrophotography.[2]

The magnetic field $\boldsymbol{B}$ formed by the magnetic roller is estimated from measured discrete data of the magnetic flux density on the sleeve surface based on the assumption that magnetic dipoles distributed on the roller and two-dimensional distribution of the magnetic flux density was calculated by superposing the magnetic flux density created by each dipole.[1] Figure 2 (b) shows the measured distribution of the magnetic flux density on the sleeve.

The dark line in Fig. 2 (c) designates the magnetic force applied to the particle on the sleeve deduced by Eq. (1). It is clearly seen that the force is almost attractive but slightly repulsive at the lower position (arrowed). It is confirmed that particles are released at this position as shown in the solid line in Fig. 2 (c) that is the measured thickness of the adhered dust on the sleeve.

References: [1] Kawamoto H (2007) *NIP23*, 43-46. [2] Kawamoto H (1996) *J. Imaging Sci. Technol*, 40, 168-170.