ELECTROSTATIC AND ELECTROMAGNETIC CLEANING OF LUNAR DUST ADHERED TO SPACESUITS. H. Kawamoto, Dept. of Applied Mechanics and Aerospace Engineering, Waseda University, 3-4-1, Okubo, Shinjuku, Tokyo 169-8555, Japan, kawa@waseda.jp

Introduction: Cleaning of lunar dust adhered to astronaut spacesuits is of critical importance for long-term lunar exploration. We are developing three kinds of cleaning devices that involve the use of electrostatic and magnetic forces.

Electrostatic Flicker: This system employs an alternating electrostatic field that forms a barrier on the surface of fabrics. Two-phase rectangular voltage is applied to parallel wires stitched into the insulating fabric, as shown in Fig. 1. Since a traveling wave is not generated by application of two-phase voltage, particles are not transported in one direction but are flicked outwards from the fabric. A lunar dust simulant was placed on the fabric and the fabric was mounted perpendicularly. Two-phase voltage was applied to parallel wires that were stitched into the fabric. Particles flicked and removed onto the floor were weighed and the cleaning rate, i.e., the ratio of flicked particles to initial particles, was determined. It was observed that the cleaning rate was less than 30%. It was difficult to flick out the dust trapped between fibers of the fabric. Thus, there is a need for further improvement in the system performance.

Electrostatic Cleaner: This system employs a combination of electrostatic separation and electrostatic transport, as shown in Fig. 2. The spacesuit fabric is placed between the lower plate electrode and the upper electrode, which contains holes. A high voltage is applied between the upper and lower electrodes. A Mylar sheet positioned under the surface fabric acted as the lower electrode. Because of the electrostatic force dust adhered to the fabric is captured by the holes of the plate electrode. The captured dust is transported by the traveling wave[1] and transferred to the collecting bag. The observed cleaning rate was less than 60%. As in the case of the electrostatic flicker, removing dust trapped between fabric fibers was difficult.

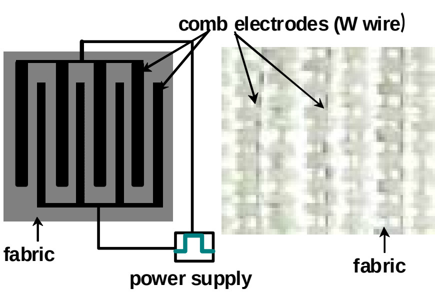

Figure 1: Electrostatic flicker of dust.

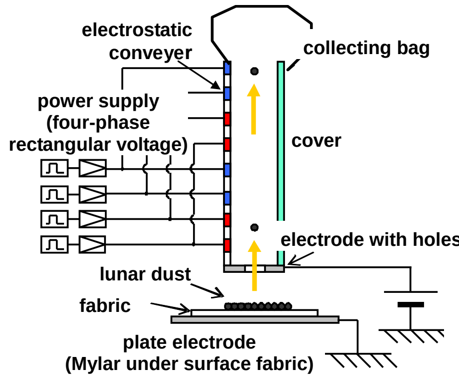

Figure 2: Electrostatic cleaner.

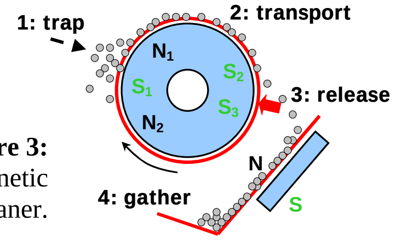

Figure 3: Electromagnetic cleaner.

Magnetic Cleaner: The operation of this device is based on the fact that lunar dust is magnetic. The device consists of a shaft, stationary multi-pole magnetic roller, rotating sleeve, plate magnet, and collection bag as shown in Fig. 3.[2] Magnetic lunar dust is attracted to the stationary magnetic roller and transported via the rotating sleeve by means of magnetic and frictional forces. The magnetic roller is designed such that a repulsive force acts on the particles at a certain position (indicated by the arrow shown in Fig. 3). When the dust is transported to this position, particles are separated from the sleeve, and are attracted to the plate magnet facing the release position. The dust particles then gather in the collecting bag that covers the plate magnet. The advantages of the system are that it is very simple, and that it works without power consumption. The observed separation rate was almost 100%, but capture rate was 40%. Therefore, the total cleaning rate was 40%. We are now developing a magnetic roller made of rare-earth magnets, to increase the magnetic force for the capturing process.

Samples of the fabric were provided by ILC Dover and Oceaneering Space Systems.

References: [1] Kawamoto H, Seki K and Kuromiya N. (2006) J. Phys. D: Appl. Phys., 39, 1249-1256. [2] Kawamoto H., Inoue H. and Abe Y. (2008) LEAG-ICEUM-SRR, 71.