Evaluation of heat storage and structural materials using resin-coated regolith

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Introduction: ISRU is an essential technology because it reduces the transportation of materials from Earth. Conventionally, regolith deposited on the lunar surface is a highly insulating material. However, if it can be endowed with heat storage properties, it is expected to provide part of the thermal energy source required for lunar overnight stays. In this study, we considered and evaluated a method of applying a small amount of resin coating to the regolith and bonding the regolith pieces together to reduce the contact thermal resistance, which is the factor that gives the regolith its insulating properties[1]. Furthermore, this regolith resin coating material has strength. Therefore, it is expected to play a role as a structural material for launch sites, living quarters, pavement, etc. The material strength was also confirmed.

Experimental methods: Regolith simulant (FJS-1) was used as the regolith, and polyamide-imide (PAI) resin was mixed as the coating resin at a ratio of 2 and 3 wt% concerning the regolith. The regolith simulant was placed in a tray and heated in an oven at 100°C. After cooling to 90°C, the resin was mixed, and the mixture was mixed in an open-type planetary mixer for 3 minutes to perform resin coating.

The material was removed from the mixer, spread on a tray, and heated in an oven at 270°C for 1 hour (Fig.1). After heating, the material was sieved through a 1mm mesh to separate the material that had mainly become lumps with a particle size of 1 mm or less from the mesh. These samples shape were glanular.

The other solid samples were screened with a 0.1 mm mesh before coating, and were then coated in the same manner. After mixing in a mixer, the mixture was placed in a cylindrical mold with a diameter of 40 mm and a height of 20 mm, and heated to solidify into a cylindrical shape (Fig.2).

Each sample's thermal conductivity was measured using the hot wire method in a vacuum 0.01Pa at 25°C.

Results and Discussion: The results of measuring thermal conductivity using the hot wire method are shown in Fig.3. It was found that the thermal conductivity of the granular sample was a little higher than that of FJS-1 in a vacuum environment simulating the lunar surface. The thermal conductivity of the solid sample was found to be significantly higher. However, it should be noted that for the sake of convenience, the degree of vacuum for the solid sample was 6 Pa and the temperature was 20°C. The reason is that the sand particles bond together, making it easier for heat to be transferred even in a vacuum. This allows heat to be stored inside, making it possible for it to be used as a heat storage material.

Fig.1 Glanular sample

Fig.2 Solid sample

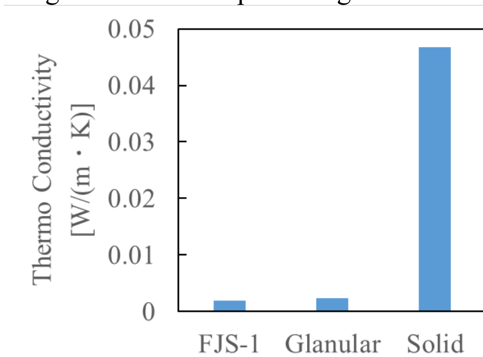

Fig.3 Thermo Conductivity in a vacuum

References:

[1] Roberto Torre, Aidan Cowley & Carlo Giovanni Ferro , *Discover Applied Sciences*, **Volume** 6 (2024) Article number 88.

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