Experimental study on thermal properties of high porosity particles for understanding physical properties of Phobos surface

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Origin of Martian satellites; Phobos and Deimos is important in clarify the history of Mars system. Martian Moons eXploration (MMX) has been selected for JAXA's next sample return mission. Observation of the physical properties of the target bodies' surfaces are expected to lead to obtaining geological information on the surface, which could constraint their origin and evolution. It is also important for developing technology for the sample return mission.

In this study, we focus on thermal inertia which is the main factor that determines the surface temperature and one of the important parameters for understanding the surface properties (ex. density and particle size) of planetary surface. The average thermal inertia of Phobos was estimated at ~70 J $m^{-2}K^{-1}s^{-½}$ from infrared observations by Mars Global Surveyor (MGS) [1].

Spectral observation data suggests that Phobos may be a primitive D-type asteroid [2]. Thermal infrared observation of a primitive C-type asteroid Ryugu by Hayabusa2 spacecraft and a primitive B-type asteroid Bennu by OSIRIS-REx spacecraft revealed that the surface of these primitive asteroids are covered with high porosity boulders and pebbles [3, 4, 5]. These observation results suggest that the materials on primitive body are highly porous. Therefore, the particles themselves on Phobos also may have a high porosity. However, experimental research on thermophysical properties for such materials is lacked. Thus, it is essential to understand the thermal properties of the high porosity particles of the Phobos surface layer.

In this study, we will conduct an experimental study on the thermal conductivity of the high porosity particles, understand the heat transport mechanism of porous particle system, and constrain the surface physical properties of primitive small bodies from thermal inertia data. This study will not only deepen the understanding of the geological background of the Phobos surface, but also provide future exploration methods such as MMX landing site selection.

In this presentation, we report the results of thermal conductivity measurements in vacuum using Phobos regolith simulant (UTPS, [6, 7]) and glass beads. UTPS is an artificially generated sample that has been used as a reference simulant of the Phobos surface for the MMX mission, and has many voids inside the grains. Therefore, UTPS was used to understand the surface condition of Phobos, which may have high voids. Based on the experimental results on the thermal conductivity of UTPS and glass beads, we will discuss about the effect of micro-porosity within grains on thermal conductivity.

Referrences

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