

Development of the thermal control compartment for scientific instruments on the lunar surface

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A future lunar landing mission SELENE-2 is being planned by Japan Aerospace Exploration Agency (JAXA) as the post lunar orbiter mission SELENE (Kaguya). Scientific objectives of the SELENE-2 are research for inner structure of the Moon, geological investigations and research of the lunar surface environment. This mission consists of the three main modules of the orbiter, the lander and the rover, and scientific devices (e.g. seismic instrument) which will be placed on the ground separately from the main modules. Some of these devices are operated through the night to acquire long-term scientific data.

The lunar surface is a severe environment for the instruments especially because of its temperature and vacuum conditions. The absence of convective cooling by atmosphere makes the ground surface temperature variable in the wide range of -150 to 100 degC in which the space electronics can hardly survive. The independent devices require a heat insulating structure to regulate inner temperature into operatable ranges of the instruments.

We conducted so far the concept design of the thermal module and computed its thermal model on the assumption of use for a lunar seismometer. The basic concept of the thermal module is a heat insulating shell compartment surrounding the scientific device. The top of the compartment is covered with an emissivity-variable heat sink. The hill shape insulator retains heat in the regolith soil in the daylight, and it can keep the device warm in the night. One issue of the compartment design is an expansion mechanism to spread out heat-insulating wall after locating the device. Comparisons of designs of the expansion mechanism, such as movements similar to folding umbrellas or power spring, are currently conducted.

A bread board model (BBM) was manufactured and its thermal-vacuum tests were conducted to determine in detail thermal binding parameters which were assumed in the computed thermal model. The situation of the lunar surface was simulated by glass beads paved in a vacuum chamber, and a temperature-controlled insulated cylinder. The thermal parameters were finally determined by measuring temperature of any parts of the BBM in thermal cycling tests.