Thermal Control of the LUNAR-A Penetrator and Lunar Heat Flow Measurement

Shinsuke Yoshida[1], Satoshi Tanaka[1], Yuka Miyazaki[2], Hitoshi Mizutani[1], Akio Fujimura[1], Akira Ohnishi[1]

[1] ISAS, [2] Earth and Planetary Sci. Tokyo Univ

In situ lunar heat-flow measurements will be carried out by using two Lunar-A penetrators, which must be maintained within allowable temperature (-5 deg C to 45 deg C) by thermal-control system.

When the temperature field around the penetrator is in unsteady state, the error of the heat-flow measurements is larger than the error of the measurements in the steady state. Therefore it is desirable that the initial temperature of the penetrator in the lunar regolith is nearly equal to the temperature around the penetrator (about -20 deg C). In this study we propose thermal designs, which realize the low temperature of the penetrator in the lunar regolith. We use heaters and two thermal control materials, UPILEX-R and SiO2-coated vaporized-Al deposited polyimide (SiO2-Al-PI) film. SiO2-Al-PI film is a new developed film which has Al-like optical properties. Because it has lower thermal conductance than Al tape, the error of the heat flow measurements induced by the uncertainty of the thermal model of the penetrator is reduced.

We have measured the solar absorptance and thermal emittance of the SiO2-Al-PI film before and after UV and Proton radiation tests and made the database of optical properties of this film. The database of optical properties of UPILEX-R is also made from the already obtained data.

By using these data and already determined thermal model of the penetrator (2D axial symmetric model), we have made thermal designs of the penetrator, which can maintain penetrator within the temperature of -5 deg C and 45 deg during the LUNAR-A mission profile (launch, trans-lunar orbit, lunar-orbit, and deployment of the penetrator). We will make more refined analysis using 3D thermal model of the penetrator, and determine the thermal design of the penetrators.