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Thermal conductivity of regolith analogues determined by different sensors using the transient probe method

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Abstract

Regolith is defined as the unconsolidated rock material of various sizes covering large parts of many airless planetary bodies, e.g. the Moon. The thermophysical properties of these surface layers, such as thermal conductivity, control to a large extent the energy balance of the body as a whole. To date only the lunar regolith thermal conductivity has been investigated. The in-situ measurements carried out during the Apollo 15 and Apollo 17 missions yielded values in the range of 10^{-2} W/mK, while the thermal conductivities of returned samples obtained in the laboratory were in the range of 10^{-3} W/mK. Theses results point out that there are still unresolved questions. Therefore, and in prospect of future in-situ missions, methodologies to determine low thermal conductivities under extreme conditions are needed, as well as suitable low conductivity calibration materials.

We report on a series of thermal conductivity measurements conducted under both ambient and vacuum conditions using several different sensors based on the transient probe method. The size of the sensors ranges from 1.5 mm to 16 mm in diameter and from ~ 100 cm to 300 cm in length. The thermal conductivity of granular material with grain sizes up to the centimetre range can be determined with the largest probe. Amongst others the JSC-1A lunar mare analogue and coarse grained high porosity lava were used as sample materials. It was found that for the large probe the conductivity is overestimated by a constant factor. Under vacuum conditions thermal conductivities in the range of 10^{-3} W/mK were determined for samples with grain sizes in the sub-millimetre range, which is consistent with previous findings. For samples in the millimetre to centimetre size range conductivities around 10^{-2} W/mK were found. The magnitude of the derived conductivities is more or less independent of the grain material.