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Calibration Measurements of the MUPUS Thermal Probe

G. Kargl (1), E. Kaufmann (2), J. Knollenberg (2), N. I. Kömle (1), M.S. Bentley and W. Macher (1)
(1) Space Research Institute, Austrian Academy of Sciences, Austria, (2) Institute of Planetary Research, German Aerospace Center, Germany
(guenter.kargl@oeaw.ac.at / Fax: +43-316-4120-652)

Abstract

The MUPUS instrument suite [1] is currently on its way to the comet Churyomov-Gerasimenko on board of the Rosetta – Philae Lander. To ensure the proper understanding of the instruments performance, extended calibration tests are required. Over the last years dedicated calibration sessions for each of the MUPUS sensors have been made, tailored to the specific sub-sensor. The thermal probe (MUPUS-PEN) is located on a 35 cm long tube, which will be inserted into the ground by a hammering mechanism. This requires a certain mechanical rigidity and stiffness of the penetrator tube. The necessary robustness of the sensor carrier is having an impact on the thermal properties of the penetrator tube. We report on a series of tests in a thermal – vacuum environment and a finite element modelling approach to determine the thermal conductivity and the specific heat of the penetrator material.

1. Introduction

The MUPUS PEN thermal probe is a set of 16 temperature sensors mounted inside a tube made of glass fibre resin enforced epoxy material. The outer side is additionally coated with a black paint for protection. All thermal sensors are printed on a Kapton sheet which is glued to the inside of the carrier tube. The whole assembly makes for a complex mechanical and even more so complex thermal instrument. Thermal properties of the single components are in principal available; however, this is no longer valid for the integrated instrument.

The only way to assess the thermal properties of the penetrator tube, are test in a controlled environment. We report here on a series of tests performed in the thermal vacuum facilities of the Space Research Institute in Graz.

Several specimens of the MUPUS PEN tube were mounted on a holder plate and shielded against ambient thermal radiation by a polished aluminium shroud surrounding the specimens. This set-up was then placed inside the vacuum chamber where the whole assembly was thermally controlled by a thermostat to an accuracy of about 0.2 K. The upper part of the tube was then heated with a heater foil and the temperature profile along the tube was measured together with housekeeping sensors on the holder adaptor and the shroud. Measurements at several temperatures from room temperature down to -70°C were made.

2. Results

The measured temperature profile along the MUPUS PEN tube specimen was then compared with a finite element model. It turned out that it was important to include not only the thermal properties like thermal conductivity, specific heat and heat capacity but also to consider the thermal radiation and emissivitivity of the penetrator tube to obtain good matches between measurement and model.

References

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