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A NOVEL DEVELOPMENT OF THE PCM HEAT SWITCH FOR FUTURE SPACECRAFT MISSIONS

Abstract

Heat switches with PCM actuators are broadly used in thermal management systems of spacecraft to automatically decouple the payload from the cold external environment in order to save energy. A concept installed in series between the radiator and the dissipative unit is considered to reject up to 10 W excess heat. The paper presents the experimental and numerical study on the passive heat switch design that can be used as a generic thermal control device for various near Earth, deep space or Mars missions.

Brno University of Technology, a new entrepreneur in space, was selected to take over the development of a heat switch from a foregoing research program that was terminated after the CDR. The baseline design was thermally and mechanically tested and it showed critical weaknesses in thermal path and extensive deformations.

Functional decomposition method of the baseline design together with the finite element analyses triggered a study on the possible modifications. A concurrent design strategy was adopted to cope with the complex entwined functionalities of parts. Beside the conventional technologies, the additive manufacturing of metals was implemented. It was verified highly efficient for solving key problems of the baseline design: material continuity, mechanical properties and mass. Experimental testing of trials was performed in parallel to support the computed analyses and to verify the manufacturing processes. The results present the sensitivity analyses of the critical design parameters and compare a variety of concept solutions, including optimization for additive technology, carbon fibres for heat transfer or space-specific thermal phenomena. As part of the results, the lessons learned are included.