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THERMAL REGULATION USING POROUS 3D PRINTED STRUCTURE OF SMALL SATELLITE

Abstract

Thermal control is extremely important in challenging space environment. There are elements with big power dissipation as communication, temperature sensitive devices as cameras and star trackers. Traditionally special thermal control system designed based on the mechanical design as additional system, with penalties increased mass and power consumption.

Recent advances in additive manufacturing technology with metals, provide new possibilities to satellite design. Passive thermal control system may be developed at the same time with structure design. This approach allows optimization of thermal interfaces and ensure satellite structure effectiveness. In this paper we present our approach which consists of a) modelling of heat pipe structures properties; b) manufacturing and post-processing; c)heat pipe charging; d) testing.

Test samples of 3D printed heat pipes were designed and manufactured during this work. Preparation process included post-processing for powder removing after additive manufacturing, cleaning, charging, sealing. Test stand for thermal conductivity of samples was designed. Samples were tested in a thermal vacuum chamber. Vibration testing was simulated to reproduce the worst case scenario during launch. Properties of heat pipes did not change, therefore all preliminary testing was considered successful.

For design and testing, we have used 1U CubeSat platform developed at Space Centre EPFL, Lausanne, Switzerland. The platform consists of slices joined by rods at Z-edges of the satellite. For the structure design of samples and satellite elements, we used CAD software: heat pipe structures embedded inside the perimeter of few slices manually, automation will be developed later. Heat pipes preparing procedures was based on the experience of operating with samples. Thermal vacuum chamber used for the thermal model verification. We will present results of our testing, however, first analysis already shows good accuracy, close to the modeling calculations.

The result of this work demonstrates workability and efficiency of presented approach. This technology shall be employed for future Cubesat developed at the Skoltech Space Centre.