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ASSESSMENT OF A LOW-COST MULTILAYER INSULATION SYSTEM FOR THERMAL CONTROL OF NANOSATELLITES

Abstract

A passive, economical and easy to assemble thermal insulation blanket has been designed to protect micro, nano and pico satellites, and their payloads as well. The structure of the Multi Layer Insulation (MLI) system has been simplified using Components Off The Shelf (COTS), so that it is composed of two types of layers: the reflective layers and the separator layers. The layers are bonded together using Kapton, glass fiber tape and a bi-adhesive tape. The reflective layers are made of Mylar polyester film, typically used in first-aid kits. The separator layers, used to prevent thermal conduction between the reflective layers, consist of a glass-fiber net used in building constructions, namely for wall plastering. The fibers are crossed together to form a mesh about 3x6 mm in size. Several samples have been manufactured, with the size of 22x22 cm, in order to fit inside the thermo-vacuum chamber of the LARES-lab at the School of Aerospace Engineering. Each sample differs from the others by the number of layers, with a maximum thickness of 2 mm. The performances of this MLI system have been evaluated. Each sample has been tested in high vacuum ($< 10^{-5}$ mbar), and temperatures on both sides of the sample have been recorded before and during the activation of a SpectrosunXT-10 Type II solar simulator. The test procedure, applied on all the samples, consisted in measuring the temperatures reached at the equilibrium but also in monitoring the transient during vacuum creation and during the heating of the sample. Two Platinum Resistance Thermometers were placed in the center of each side of the sample; the thermometers were fixed to the surface by means of a thermal conductive double sided adhesive tape. Two additional sensors were placed on the walls of the vacuum chamber. The highest recorded temperature on the front-facing layers of a tested specimen was 161.9°C. On some specimens, temperature differences of about 95°C have been recorded between the layer facing the Sun simulator and the opposite one (in shadow). Heat transfer was reduced through the use of a larger number of layers in the sample, as well as by varying the front surface emissivity. The tests demonstrated that the COTS-composed MLI system has both good insulation properties and good resistance in space environment. This paper will describe the manufacturing procedures, the characteristics of the MLI systems used, the experimental set-up and the relevant results.