Paper ID: 68819
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IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Vehicles – Mechanical/Robotic/Thermal/Fluidic Systems (7)

Author: Ms. Jana Catuche
United States, jana.catuche@udc.edu

Prof. Mohammad Reza Shaeri
United States, mohammadreza.shaeri@udc.edu
Mr. Michael Ellis
Advanced Cooling Technologies, Inc., United States, mike.ellis@1-act.com

ADDITIVELY MANUFACTURED HIGH-POWER-DENSITY COLD PLATES

Abstract

For the first time and to respond thermal management of high-power density electronic components, an additively manufactured cold plate (CP) with integrated evaporator wick structures and a non-permeable barrier (NPB) was developed and tested during a NASA MUREP program. This CP, called NPB-CP, combines the benefits of mechanically pumped two-phase (PTP) cooling with those of capillary two-phase cooling. The PTP continuously pumps working liquid (refrigerant R245fa) into the CP and the capillary cooling takes place by evaporation/boiling from wicks. The novelty of NPB-CP is having a NPB as a rigid separator to prevent flowing the liquid over the evaporator wicks and avoid the flooded wicks. Totally, eight heaters were attached to the CP (four at the top and four at the bottom of CP). The CP was inserted inside a PTP loop. Temperatures and pressures at different locations in the loop were measured. The flow rate was set at 1.0 l/min. The heat input to each heater was increased by regulating the voltage of the variable transformer. At each heat input, data were collected when the system reached a steady state condition. The performance of NPB-CP was compared with that of a bare CP (B-CP), which was an additively manufactured CP without any wick structure and NPB. The thermal performances were evaluated by the temperature non-uniformity across heaters, and the maximum heat flux. The temperature non-uniformity is the percentage of difference of maximum and minimum heater temperatures divided by the average temperature of heaters. Due to preventing flooded evaporator wicks, the NPB-CP operated in heat flux exceeding 259 W/cm2 and achieved temperature non-uniformity of 39