Pressure Drop and Temperature Drop Analysis of the Optimal Top Cap Design of Evaporator of the Micro Loop Heat Pipe.

The Micro Loop Heat Pipe (LHP) is a revolutionary device that may be used to cool microelectronics, solar collectors and other devices in microgravity applications. It is a two phase cooling device with extremely high effective thermal conductivity that utilizes the capillary forces developed inside its wicked evaporator and the thermodynamic pressure difference developed between the evaporator and the condenser to circulate a working fluid through a closed loop. The most important part of the loop heat pipe is the evaporator. It consists of top cap, coherent silicon porous wick and the compensation chamber. Not much studies and experiments have been performed in determining the efficient and optimal design of the top cap. The main problem with the top caps designed in the past was associated with the conduction of heat from the source to the wick and this reduced the heat dissipation ability of the loop heat pipe. Five new optimal top cap designs are determined and fabricated to overcome this problem with the provision of conduction pathways. Each of the five design is discussed briefly. The conditions used for arriving at the optimal solutions are discussed. Calculation of pressure drop and temperature drop is very essential for the determination of optimal solutions of the top cap. For the trapezoidal slot and cone mesas design the pressure drop and temperature drop calculations are discussed in detail. Geometry of the external vapor reservoir for the trapezoidal slot top cap is designed for optimum pressure drop. Variation of pressure drop in the top cap with respect to the porosity in the coherent porous silicon wick is discussed and analyzed in detail. This helps in determining the optimum dimensions for pore patterning. Initially the pressure drop for each design is approximately calculated using the simple 2D microchannel principle. The exact pressure drop calculations are done numerically using a finite volume commercial flow solver FLUENT6.1. The temperature drop calculations are done using finite element modeling in ANSYS6.1. It is assumed that all the pores have uniform mass flow rate and are at saturation conditions during the phase change.