INVESTIGATION OF A HEAT TRANSFER DEVICE FOR ELECTRONICS COOLING

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Abstract

One of the problems of microelectronics cooling – the high degree of integration modern chips and electronic circuits. Such high density of a heat power cannot be dissipated usual coolers even if they are equipped with classic heat pipes. However, in some cases an application of pulsating micro heat pipes can solve a thermal problem of microelectronics. In this paper the pulsating micro heat pipe (PMHP) for cooling of electronic elements with high-density heat stream is offered. The results of comparative tests of a heat transfer performance of PMHP are represented. Efficiency of PMHP heat pipe using in electronics cooling is shown.

KEYWORDS

Pulsating micro heat pipe, electronics cooling.

INTRODUCTION

Intensive development of microelectronics and computer technics is accompanied by increase of capacity of semi-conductor chips, hence, increase of allocated heat. Miniaturization of devices, in turn conducts to increase of density of assembly of the electronic equipment. In aggregate, it demands more effective methods of cooling. The problem of cooling, in particular, limits use of more productive microprocessors. The degree of integration of the electronic equipment at times achieves such level, that so high density of a heat stream cannot be removed usual coolers even they are equipped with usual micro heat pipes.

One of directions of efficiency increase of electronic device cooling is a use of pulsating heat pipe. Pulsating heat pipe possess high thermal capacity and differ from a usual heat pipe that circulation of the heat-carrier inside is carried out without the aid of capillary forces, and with the help of pulsating movement of vapor and liquid slugs. For this reason in a pulsating heat pipe there is no wick that provides simplicity and cheapness of a design.

PULSATING MICRO HEAT PIPE DESIGN

In the given work the design of a pulsating micro heat pipe [1-3], which can be used for cooling computer processors and other electronic devices with high density of heat radiation, is offered.

The PMHP represents the two phase closed loop in which the heat-carrier pulses Figure 1. The loop consists of the U-shaped capillary canal and expansion chamber. This sample was made of a heat-resistant glass to have an opportunity to carry out visual experimental observation over process of a pulsating heat transfer.

Before realization of experiments, the expansion chamber was filled by necessary quantity of heat-carrier and then was hermetically sealed by capillary tube with the silicone sealants. As the heat-carrier, water was used. Using heater attached in the bottom part of a capillary tube loop was realized heat input. After heat input on internal wall of a capillary canal there were bubble nucleus, and then the vapor phase started to extend sharply with the subsequent collapsing. Pulsations were observed. Thus, expansion of a vapor slug occurs serially that in one side, in another Figure 2. The amplitude of these oscillation increased with rise in water temperature up to some value at which the heat-carrier accumulated in the expansion chamber and pulsations stopped. Supervision over pulsations in various diameters of the capillary channel from 0.5 mm up to 2 mm ware carried out.

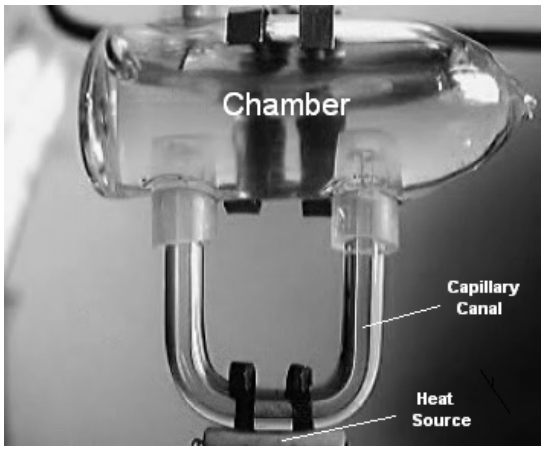


Fig. 1. Pulsating micro heat pipe

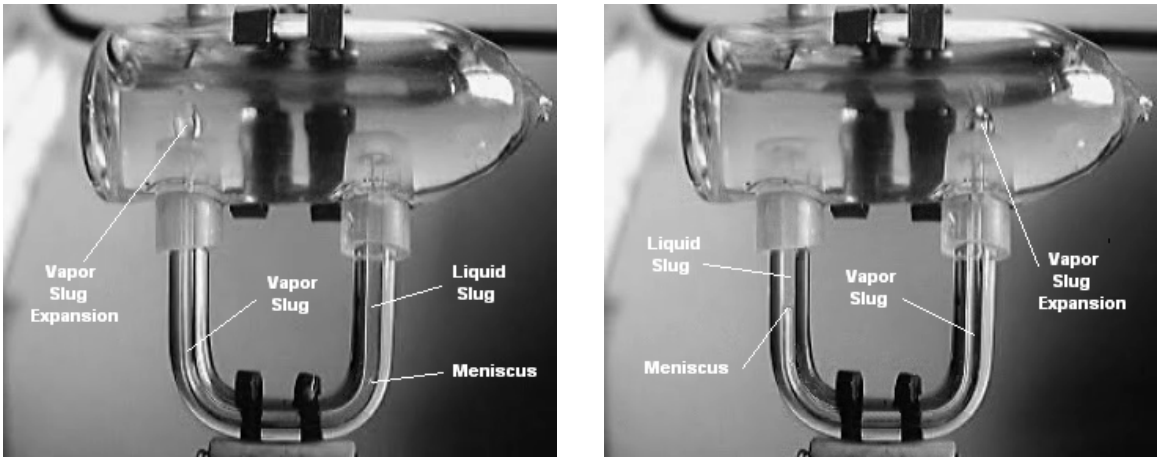
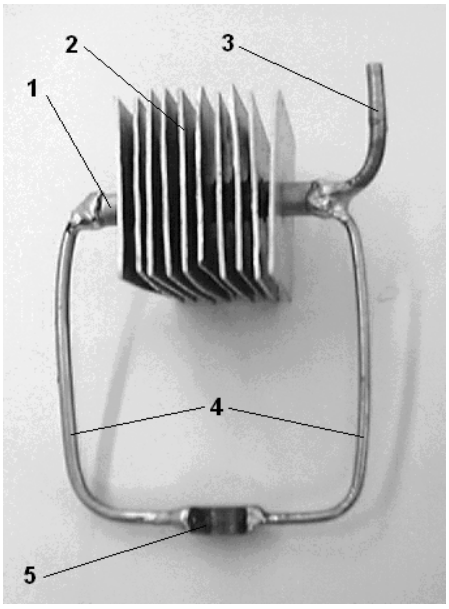


Fig. 2. Pulsating expansion of the vapor slug



COOLING DEVICE DEVELOPMENT

After carrying out of visual experiments, the prototype model of PMHP shown on figure 3 has been made. The expansion chamber 1 were made of a copper tube on which put on fins 2. Transport zone of a heat pipe - two capillary knees 4 connecting the evaporator and the condenser, were made of stainless steel.

Fig. 3. Prototype model of PMHP

1- Expansion chamber (condenser)
2- Fins
3- Charging connection
4- Capillary canal
5- Cupper substrate (evaporator)

Heat power was brought to a copper substrate inside which there was evaporating part of PMHP. The given experimental model has shown the maximal heat-transmitting capacity equal 8 W. Thus the removed density of a heat flow was about 10 W/cm^2.

In figure 4 the temperature curves of the evaporator and the chamber are shown at initiation of pulsations. The point **A** specifies by the beginning of inputting of heat power. It is visible, that the temperature of the evaporator sharply grows until the moment when there comes process of pulsations in a point **B**. At this moment, the temperature of the condenser sharply increases, coming nearer up to temperature of the evaporator with the minimal difference.

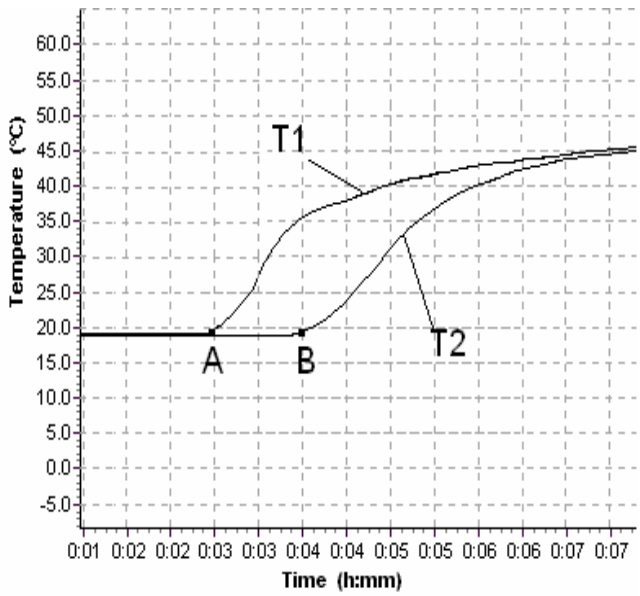


Fig. 4. Initiation of pulsations

A – Heat input
B – Initiation of pulsations
T1 – evaporator temperature
T2 – condenser temperature

COOLING UNIT FOR ELECTRONICS

For testing developed PMHP with reference to electronics cooling has been made a cooler which design is shown on Figure 5. In the given model of a cooler, the evaporating part is built in inside of a copper substrate, which fastens on the electronic chip, for example the computer processor. Comparative experiments have shown, that heat capacity of this cooler has made 70 W, when capacity of same cooler without PMHP has made 50W.

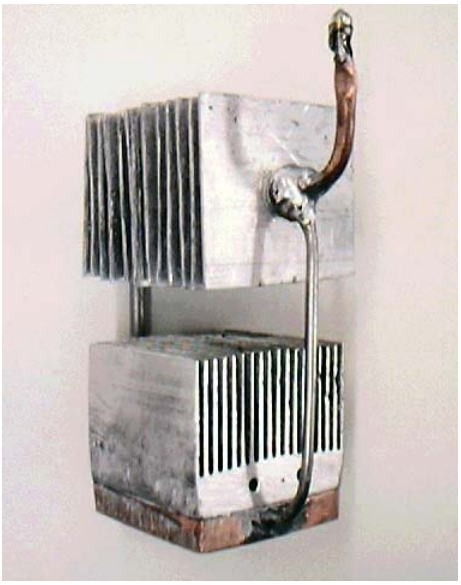


Fig. 5. Experimental cooler

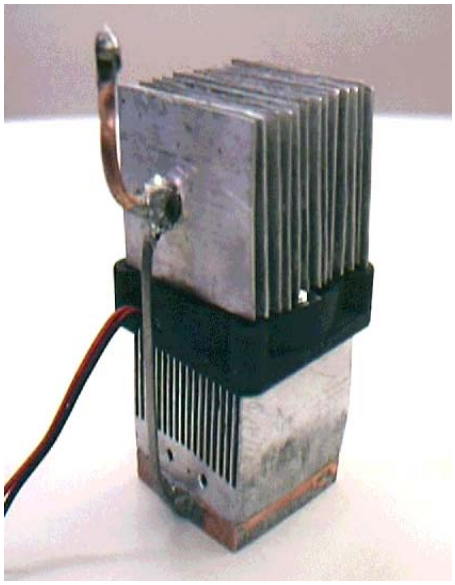


Fig. 6. Cooler with fan

CONCLUSIONS

Results of the carried out work have shown an opportunity of use of the developed pulsating micro heat pipe for cooling electronic devices, for example processors in computer technics.

The developed heat transfer device has an evaporating part of the small size, which can be indefinitely small. This feature allows removing the high density of a heat flow, and it allows mounting similar pulsating micro heat pipes on a thermal substrate with small area.

Reference

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