ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Performance Improvement of a Micro Channel Heat Sink

Guthula Satish
AIMS College of Engineering, Mummidivaram, Andhra Pradesh, India.

Mr. K Bala Murali Krishna
AIMS College of Engineering, Mummidivaram, Andhra Pradesh, India.

Mr. D Kishor Babu
AIMS College of Engineering, Mummidivaram, Andhra Pradesh, India.

ABSTRACT:

Thermal management of components is the most important consideration for electronic cooling. The microchannel heat sinks have been developed by many researchers in recent years. Numerous literatures have been published on fluid flow and heat transfer characteristics of microchannel. Tuckerman and Pease have demonstrated a heatsink with micro channel. In this research they found that microchannel heat sinks can extract more heat and are preferred for chip cooling in VLSI circuit. Have manufactured a counter flow microchannel heat exchanger by precision cutting. That microchannel heat exchanger is tested with water as working fluid for convective heat transfer. A volumetric heat transfer coefficient of 0.324 MW/(m3K) was obtained. Have manufactured a trapezoidal shaped microchannel heat exchanger by diamond machining. In that heat exchangers counter flow arrangement is provided.

In this present study we will develop a new models of micro channel heat sink which can be manufactured by three layers namely the base, core and top layer, the base will be in contact with the heating source and the fluid will flow through the core, here different geometries of the core are developed and tested using some fem software, 3D models of the components are developed using Catia V5

INTRODUCTION

Microchannel Heat Sinks

With component heat dissipation levels reaching 500 W/cm^{2}and beyond, conventional air cooling systems are inadequate for removing excess heat. Research has intensified toward developing more innovative chip cooling techniques. The ultimate goal is to reduce thermal resistance from the chip junction to ambient, and keep the chip's junction temperature as low as possible.

For high performance CPUs, graphics cards, power amplifiers and other devices, air-cooling has proven ineffective at dissipating high heat fluxes. Heat transfer methods such as heat pipes, vapor chambers, Nanomaterials, liquid cooling and miniature refrigeration systems have been attracting more interest.

Liquid-cooled microchannel heat sinks and coolers have been shown to be a very effective way to remove high heat load. A large heat transfer coefficient can be achieved by reducing the channel hydraulic diameter. In a confined geometry the small flow rate within microchannels produces laminar (smooth) flow, which results in a heat transfer coefficient inversely proportional to the hydraulic diameter. In other words, the narrower the channels in the heat sink, the higher the heat transfer coefficient.

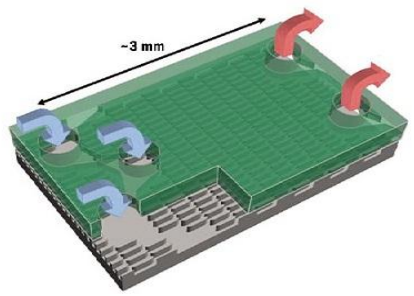

Fig.1 Micro Channel Cooler Showing Heat Exchanger Zones

Forcing a fluid through a greater number of small channels vs. a smaller number of larger channels increases the level of heat transfer from the hot source,

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

e.g. chips, cards, into the flowing liquid. There are more channels for a small hydraulic diameter than large ones. So the heat sink with a smaller hydraulic diameter has better overall thermal performance.

The use of microchannels as a viable cooling solution was first proposed in 1981 by Tuckerman and Pease, who designed and tested an integral, water-cooled heat sink by etching microscopic channels 50 µm wide and 300 µm deep on the silicon substrate. They reported achieving a high heat flux of 790 W/cm^2 with a temperature rise of 71°C above the inlet water temperature. Tuckerman's work was well received by the electronics community, and many extensive studies have since been conducted on different aspects of microchannels in electronic cooling.

Even though the use of microchannel devices seems very promising, they require a significant amount of power to push the fluid through the channels in high heat flux applications. One solution is to use convective boiling heat transfer and two-phase flow in the microchannels. Use of boiling heat transfer could improve the efficiency of microchannels in two ways: it reduces the pumping power required to push the fluid through the channels, and at its time of phase change, the boiling coolant absorbs energy from the hot surface of the microchannel heat sink, substantially increasing the heat transfer coefficient.

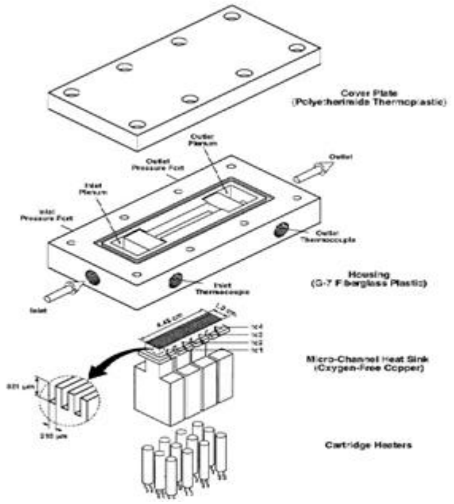

Fig.2 Microchannel Heat Sink Test Module

The heat transfer ability attained with two-phase flow and boiling inside microchannels is limited only by its critical heat flux (CHF). The CHF of boiling at a surface refers to the heat flux at which the surface heat transfer coefficient suddenly drops. Exceeding the CHF will lead to a sudden jump in surface temperature which will result in the failure of an electronic component.

While using microchannels to cool electronics is attractive because of their very high heat transfer coefficient, their use and implementation is very challenging. Factors such as cost, manufacturing, pump selection, filtering requirements to prevent channel clogging, and space constraints must be evaluated before one commits to using microchannels in a system. The research in this area is ongoing and the implementation of this concept will become more widespread once the practical difficulties mentioned above are resolved.

ANALYSIS

CFD analysis of basic model microchannel heat sink with H14

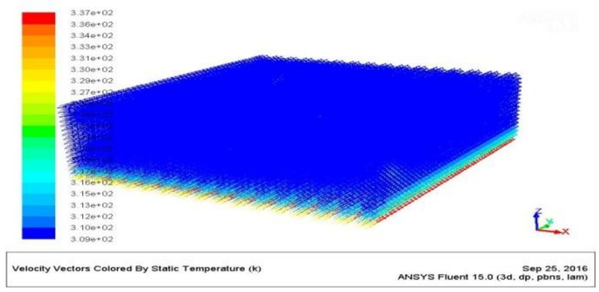

Fig.3 CFD analysis showing static temperature for H14

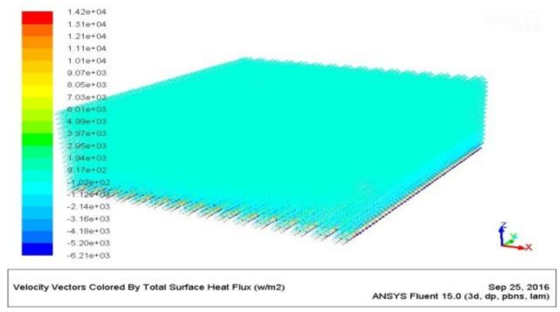

Fig.4 CFD analysis showing Total surface heat flux for H14

Mass Flow Rate	(kg/s)
Heater	0
Inlet	1.3328e-08
Interior-_msbr	-6.2589631e-07
Outlet	-1.329901e-08
wall-_msbr	0
Net	2.8989808e-11

Total Heat Transfer Rate	(w)
heater	0.16328338
inlet	-0.0037143458
outlet	-0.00017425759
wall-sbr	-0.15939491
Net	-1.315419e-07

Mass Flow Rate	(kg/s)
heater	0
inlet	1.3327998e-07
interior-msbr	-6.2593544e-06
outlet	-1.3308215e-07
wall-msbr	0
Net	1.9782907e-10

Total Heat Transfer Rate	(w)
heater	0.17012226
inlet	-0.015155879
outlet	-0.0018700995
wall-msbr	-0.15308909
Net	7.1940367e-06

CFD analysis of basic model microchannel heat sink with copper

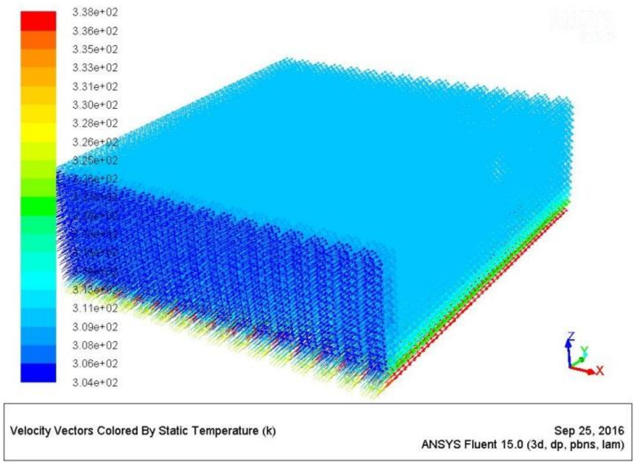

Fig.5 CFD analysis showing static temperature for copper

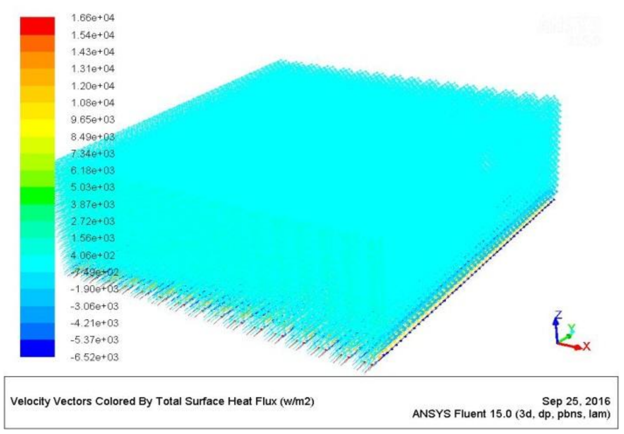

Fig.6 CFD analysis showing Total surface heat flux for copper

TABLES

Thermal Analysis Report

Thermal analysis of heat sink with h14	Temperature(°C)		Total Heat Flux(W/Mm²)		Directional Heat Flux(W/mm²)	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Basic Model	70.629	73.76	5.48e-04	0.77682	-1.94e-02	1.94e-02
Model 2	72.429	75.703	1.41e-04	1.2315	-0.21565	0.36458
Model 3	61.83	66.813	1.89e-03	1.6663	-0.37144	0.41955
Model 4	94.802	101.13	1.18e-03	2.2256	-1.0153	0.89066

Table.1 Steady state thermal analysis results for different models of microchannel of H14

Thermal Analysis Of Heat Sink With Copper	Temperature(°C)		Total Heat Flux(W/Mm²)		Directional Heat Flux(W/Mm²)	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Basic Model	73.495	75.188	1.69e-03	0.7455	-0.43861	0.43861
Model 2	73.384	75.301	1.27e-03	1.2056	-0.4745	0.47744
Model 3	62.419	65.31	4.31e-04	1.6825	-0.37476	0.42165
Model 4	95.64	99.261	7.14e-04	2.2241	-0.92725	0.94367

Table.2 Steady state thermal analysis results for different models of microchannel of Copper

CFD Analysis Report

Mass Flow Rate (Kg/S)	Basic Model	Model 2	Model 3	Model 4
H14	2.90e-11	4.69e-12	3.35e-12	5.49e-12
Copper	1.98e-10	4.69e-12	3.35e-12	5.49e-12

Table.3 CFD analysis-Mass Flow Rate results for different models of microchannel.

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Total Heat Transfer Rate (W) From Heater	Basic Model	Model 2	Model 3	Model 4
H14	0.163283	0.1685611	0.2109391	0.15963343
Copper	0.170122	0.1664593	0.22367207	0.16732258

Table.4 CFD analysis-Heat Transfer Rate results for different models of microchannel.

CONCLUSION

Here we conducted thermal and CFD analysis on four different heat sink models in which first one is a basic model is presently used in cooling applications in computer and other electronics, later designs are developed from the basic models to improve the cooling effect

From the study we can observe that even though we increased the surface area in model two the temperature is slightly raised but these temperatures are much reduced in in model three and then increased in fourth model due reduction in surface area tough we know the reason this attempt is made to check whether turbulence can play

Hear in both studies model 3 is doing better in thermal analysis model three recorded 9.4% less temperature when made with Aluminium and 13.13% less temperatures when made with copper similarly in CFD analysis heat removed from the source is 22.5% more in Aluminium model and 31.47% in copper model

FUTURE SCOPE

This study can be carried forward by developing more heat sink models and cooling fluids as these are micro channels we can’t use all kinds of fluids

REFERENCES

1. International Conference on Advances in Computational Modeling and Simulation Optimization and Numerical Simulation of Multi-layer Microchannel Heat Sink Baodong Shao*, Lifeng Wang, Heming Cheng, Jianyun Li

2. Zeng-yuan, GUO. Focus of current world heat transfer field-cooling of microelectronics devices. Chinese Science Fund; 1988, 2: 20-25

3. Kleiner, M. B., Kuehn, S.A. and Haberger, K. High performance forced air cooling scheme employing micro channel heat exchangers. IEEE Transactions on Components, Packaging and Manufacturing Technology Part A; 1995, 18 (4): 795-804

4. Chong, S. H., Ooi, K. T. and Wong, T. N. Optimization of single and double layre counter flow microchannel heat sinks.Applied Thermal Engineering; 2002, 22: 1569-1585

5. Thermofluidics and energetics of a manifold microchannel heat sink for electronics with recovered hot water as working fluid ChanderShekhar Sharma a, Manish K. Tiwari a, Bruno Michel b, DimosPoulikakos a,⇑

6. G.E. Moore, Cramming more components onto integrated circuits, Electronics (1965) 114–117.

7. J.G. Koomey, Worldwide electricity used in data centers, Environ. Res. Lett. 3 (3) (2008) 034008.

8. Theoretical and Experimental Investigation of Heat Transfer Characteristics through a Rectangular Microchannel Heat Sink Dr. B. S. Gawali 1, V. B. Swami 2, S. D. Thakre 3

9. Analysis of three-dimensional heat transfer in micro-channel heat sinks WeilinQu, IssamMudawar *Boiling and Two-phase Flow Laboratory, School of Mechanical Engineering, Purdue University, West Lafayette, IN 47907, USA

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

10. Numerical Study of Different Cross-Sectional Stacked Microchannel Heat Sink.

Author Details

Guthula Satish received the B.Tech degree in Mechanical engineering from Prasiddha college of Engineering and technology, JNTUK, Kakinada, Andhra Pradesh, India, in 2014 year, and perusing M-Tech in CAD/CAM in AIMS College of Engineering, Mummidivaram, Andhra Pradesh, India.

Mr. K Bala Murali Krishna (ME), presently working as associate professor in AIMS college of Engineering, Mummidivaram, Andhra Pradesh, India

Mr. D Kishor Babu (MBA,M-tech), presently working as associate professor in AIMS College of Engineering, Mummidivaram, Andhra Pradesh, India.