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Analysis of Electronic Cooling with Natural Convection and Radiation

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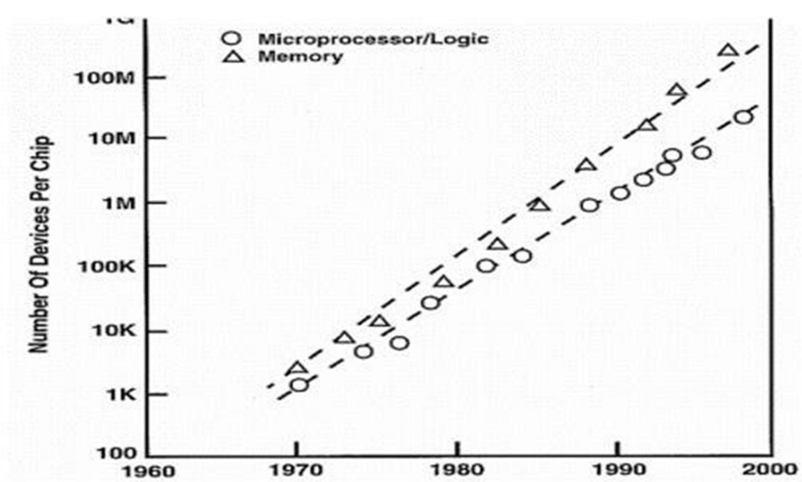
Abstract: The size of the electronic instruments as day by day decreases drastically and simultaneously the number of functions per chip increases hugely. So, it's a great challenge to remove the heat generated by the chip efficiently. Many kinds of research works are going on in this direction for the past few decades. In this study the cooling effects of the chip are analyzed using CFD simulations. The single chip module is modelled using space claim. The analysis is carried out in static module by solving the governing equations for a flow through a channel via obstruction. The laminar flow is assumed for the temperature variation analysis in the chip. The three metals are copper, aluminium and silver are analyzed for temperature variation in chip. Form this analysis it was found that silver is the best metal to transfer the heat from the chip.
Keywords: Electronics cooling, CFD, chips, cooling effect.

I. INTRODUCTION

Since the development of the first electronic digital computers in the 1940s, the effective removalof heat has played a key role in ensuring the reliable operation of successive generations of computers. The Electrical Numerical Integrator and Computer (ENIAC), dedicated in 1946, has been described as a ''30-ton, boxcar-sized machine requiring an array of industrial cooling fans to remove the 140 KW dissipated from its 18,000 vacuum tubes''. In the year 1947 the first transistorwas successfully demonstrated the development of generations of computers yet to come. As a replacement for vacuum tubes, the miniature transistor generated less heat, was much more reliable, and promised lower production costs.

During the 1960s small scale and then medium scale integration (SSI) and (MSI) led from one device per chip to hundreds of devices per chip. The trend continued through the 1970s with the development of large-scale integration (LSI) technologies offering hundreds to thousands of devices per chip. In 1980s with the development of very large-scale integration technologies offering thousands to tens thousands of devices per chip. It leads to be increase in temperature when the chip in working.



The usage of electronic components liberates high heat because it consists of electronic chips. During working condition electronic chips liberate high heat. if we didn't remove the heat from thechips thus causes the material damage or properties of material change or sometimes leads to blast.

II. MODELING AND ANALYSIS

A. Modeling A Chip

In this work modelling of chip is done using space claim software considering chip as a heat source and tip of the chip as heat sink. The modelling of the chip is shown in Fig 1 to Fig 2.

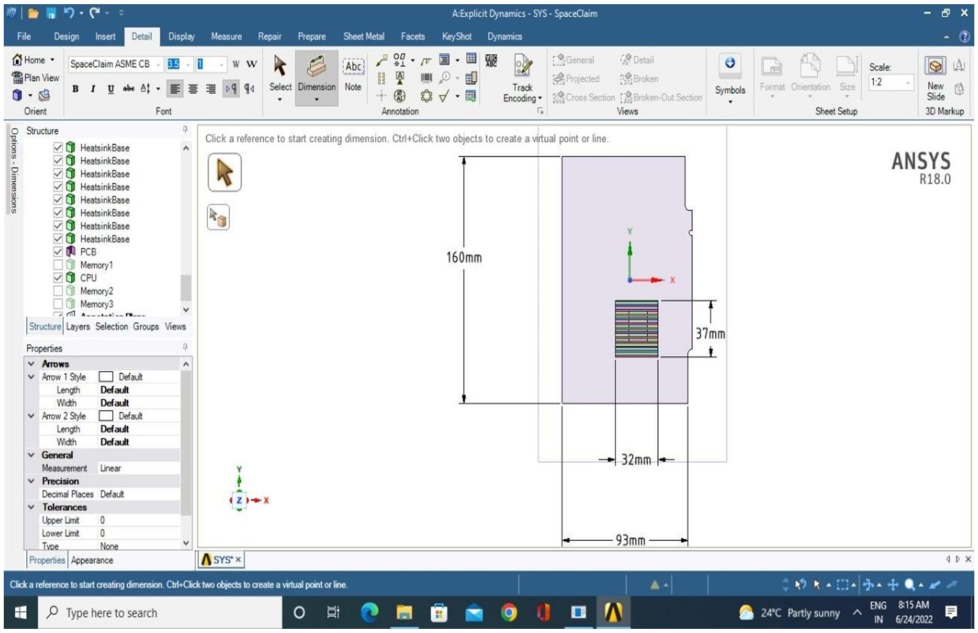


Fig 1 Electronics chip top view

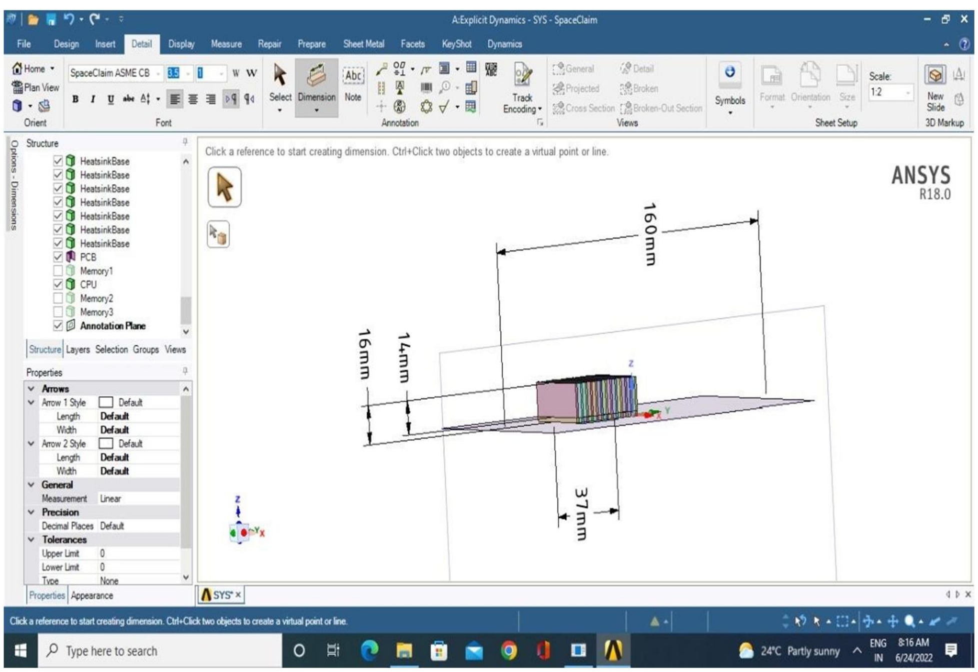


Fig 2 Electronics chip side view

B. Materials

The materials used in this project for chip are copper, aluminum and silver. The properties of copper are density 8978 kg/m3, specific heat is about381 j/kg-k, and thermal conductivity is 387.6 w/m-k. Aluminium (Al) density is 2,710kg/m3, specific heat is about 900 j/kg-k, thermal conductivityis 247w/m-k. Silver (Ag)3 density is 10800kg/m3, specific heat is about 0.237 j/kg-k, thermal conductivity is about 419w/m-k.

C. Apply Boundary Conditions

The project implies that it is a NATURAL CONVECTION that means we didn't use any external forces to cool the chip. The one boundary condition Is given for the chip that is temperature at theinlet, the emissivity given to the wall is 0.9.

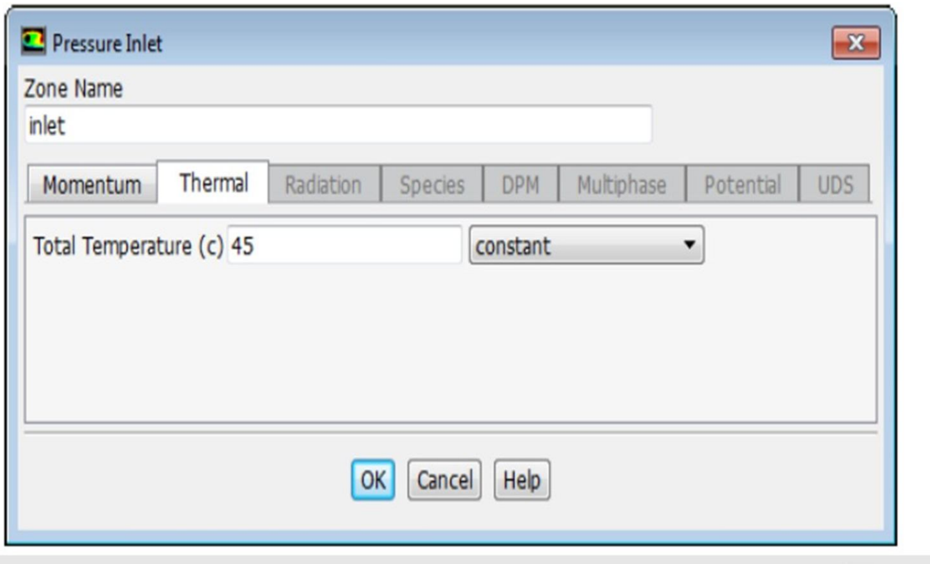


Fig 3 Inlet temperature

III. RESULTS AND DISCUSSION

By using the natural convection with radiation, the thermal analysis of chip with three different materials are shown in Fig …. The three materials sink temperatures are shown in table … For aluminum the sink temperature is about 360 K for copper it 365 K. It is observed from the results that chip made of silver is having highest sink temperature of 370 K indicating that maximum heat transfer occurs from the chip.

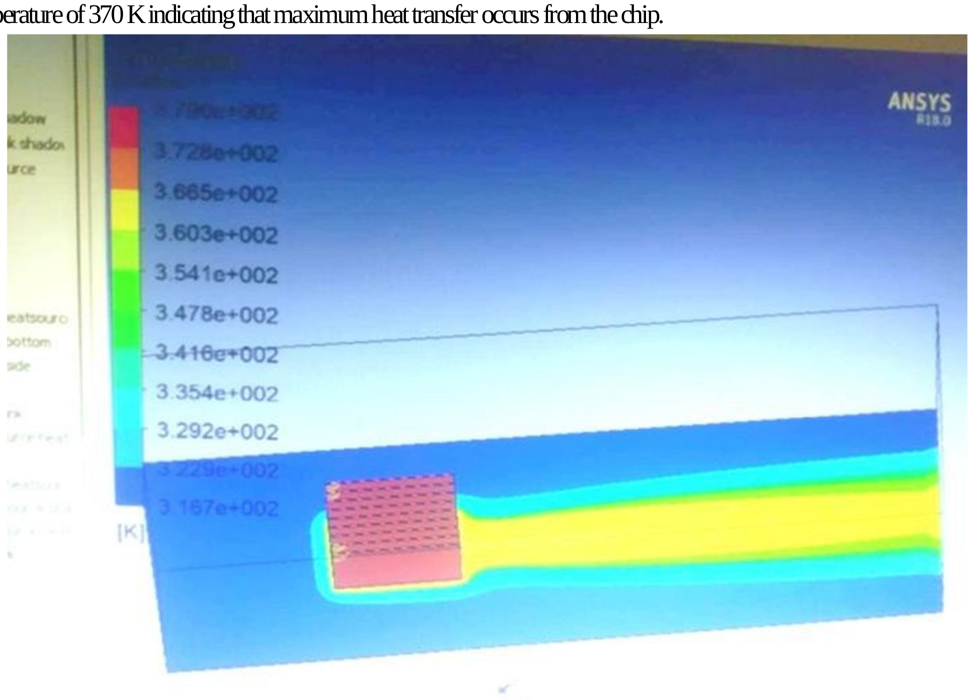


Fig 4 CFD analysis for aluminium

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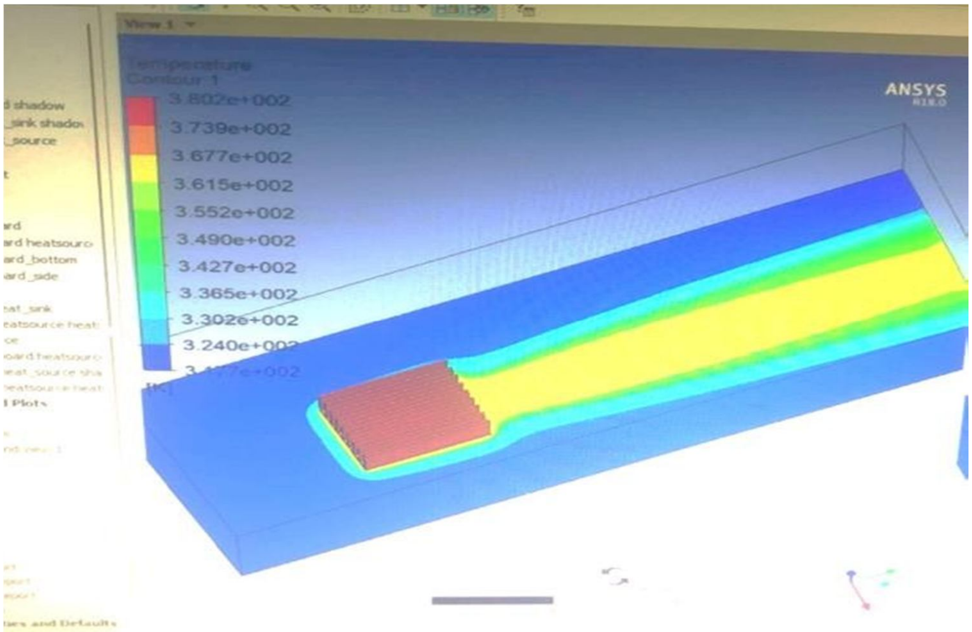

Fig 5 CFD analysis for copper

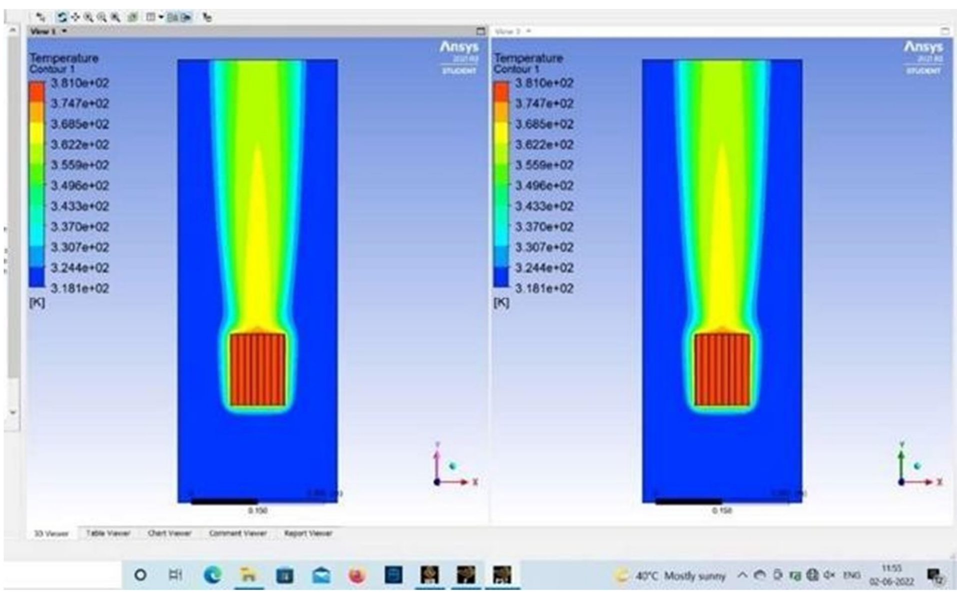

Fig 6 CFD analysis for silver SINK SINK TEMPERATURE FOR COPPER, SILVER AND ALUMINIUM.

S.NO	MATERIALS	Sink TEMPERATURE
01	ALUMINIUM	360 k
02	COPPER	364.5 k
03	SILVER	369.5 k

IV. CONCLUSIONS

The electronic chip cooling is analyzed using computational fluid dynamics. The temperature variation in the sink of chip utilizing copper, aluminum, and silver is obtained. It is concluded that silver is the best material to remove the heat generated in the electronics compared to copper and aluminum.

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