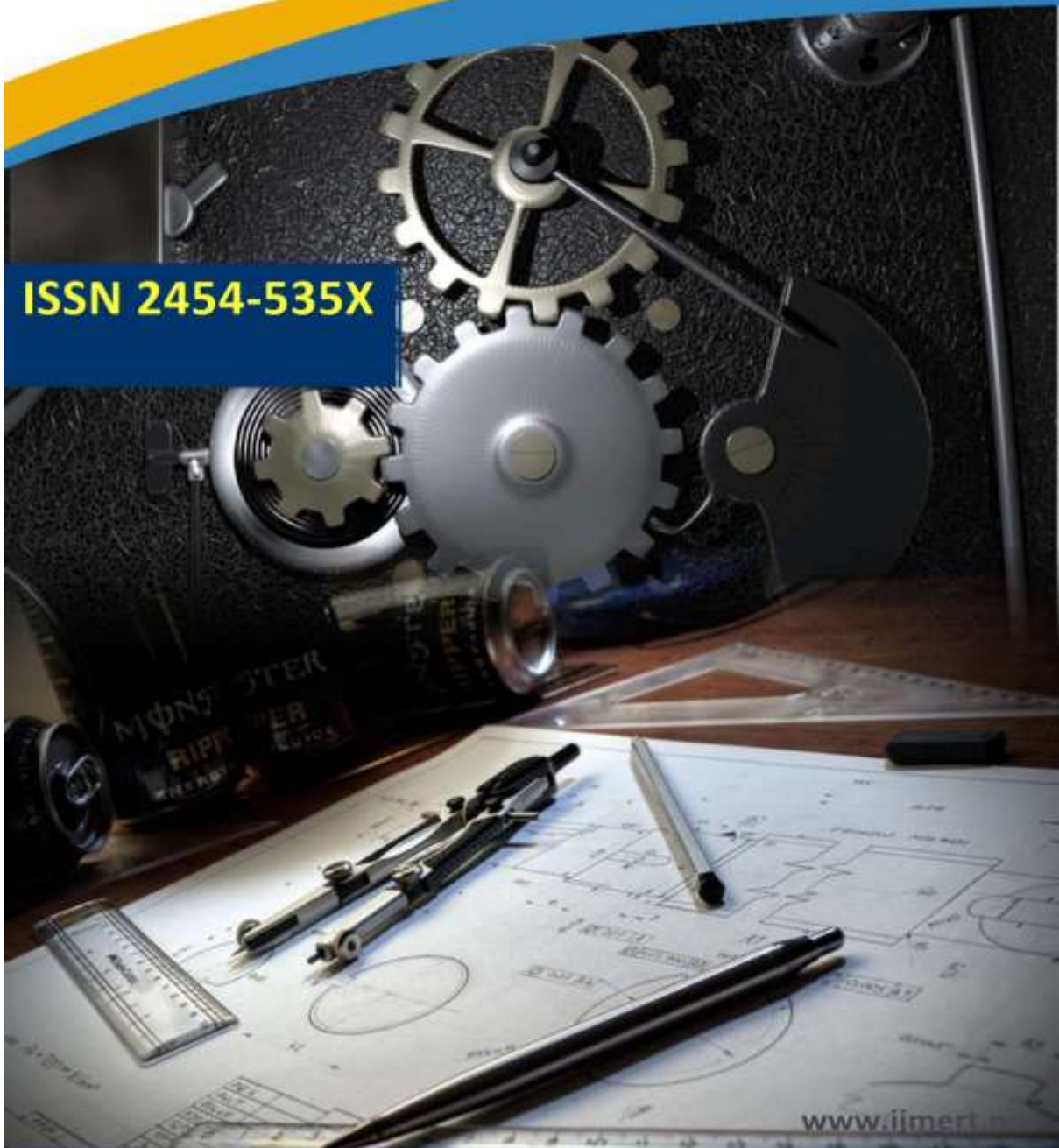




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COMPUTATIONAL FLUID ANALYSIS ON ELECTRONIC DEVICES TO DEMONSTRATE THE THERMAL EFFECTS ON MATERIAL

K.L. Sai Kishore , Rama Krishna Kadiam, S. Anjaneyulu, V. Sandhya Rani

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. CFD simulations have become more and more widely used in studies of electronic cooling. In this study the cooling effects of the chip are analyzed using CFD simulations. The single chip module is modeled using space claim. The analysis is carried out in fluent module by solving the governing equations for a flow through a channel via obstruction. The laminar flow of viscous model for the two metals (copper, aluminum) is analyzed for temperature variation in chip.

Keyword: space claim, fluent, laminar flow, surface to surface radiation, free convection, chip cooling.

Introduction

Electronics devices and equipment now permeate virtually every aspect of our daily life. Among the most ubiquitous of these is the electronic computer varying in size from the handheld personal digital assistant to large-scale mainframes or servers. In many instances, a computer is embedded within some other devices controlling its function and is not even recognizable as such. For example, in automobiles, space crafts, missiles, satellites, etc. The applications of computers vary from games for entertainment to highly complex systems supporting vital health, economic, scientific, mobile phones, and defense activities. The dimensions of the instruments also decrease day by day but simultaneously the number of functions increases as a result the functions per unit

volume are increasing hugely, this is most visible in portable electronic components, such as laptops, cell phones, digital cameras, and other items around us, where an increasing number of functional components are squeezed into an ever-shrinking system box. Compact packaging is also in progress in desktops and server computers, driven by the need to reduce the box dimensions and cut wiring distances between electronic devices. In a growing number of applications, computer failure results in a major disruption of vital services and can even have life-threatening consequences. As a result, efforts to improve the reliability of electronic computers or electronic chips are as important as efforts to improve their speed and storage capacity.

^[1] Assistant Professor, Department of mechanical, Pragati Engineering College(Autonomous), Surampalem, India.

Since the development of the first electronic digital computers in the 1940s, the effective removal of 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”. As with ENIAC, all early computers up to 1957 used vacuum-tube electronics and were cooled with forced air.

Statement of the Problem

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, and then through the 1980s with the development of very-large-scale integration technologies offering thousands to tens of thousands of devices per chip. This trend continued with the introduction of the microprocessor. It continues to this day with INTEL and others projecting that a

Objectives of the study

- Surface to surface
- The material of the chip replaced by different materials i.e copper, aluminum.
- Aluminum dissipates heat up to 15 times faster than stainless steel.
- Copper has 60% better thermal conductivity rating than aluminum and almost 30 times more thermal conductivity than stainless steel.

microprocessor chip with a billion or more transistors will be a reality before 2010. In many instances, the trend toward higher circuit density has been accompanied by increased power dissipation per circuit to provide reductions in circuit delay (i.e., increased speed). The need to further increase packaging density and reduce the signal delay between communicating circuits led to the development of multi-chip modules beginning in the late 1970s and is continuing to this day, representing the chip heat flux and module heat flux. As can be seen the chip heat flux increases at a cumulative growth rate (CGR) of 7 % per year, and heat flux associated with bipolar circuit technologies steadily increased from the very beginning and really took off in the 1980s. There was a brief respite with the transition to CMOS circuit technologies in the 1990s, but the demand for increased packaging density and performance reasserted itself, and heat flux is again increasing at a challenging rate. positrons, neutrons, and other particles that constitute the secondary cosmic rays that are produced after primary cosmic rays interact with Earth's atmosphere. Oxygen to completely oxidize all the fuels it contains but there is no excess oxygen to react with the nitrogen in the mixture to form nitrogen oxides.

Review of Literature

Chang YW [1] observed conventional cooling approaches are increasingly falling apart to deal with the high cooling demand and thermal management challenges of emerging electronic devices. Thus, high performance chips or devices need innovative techniques, mechanisms and coolants with high heat transfer capability to enhance the heat removal rate in order to maintain their normal operating temperature. Lasance C & Simons R [2] there are many ways to remove heat from a device, however, nearly all of them are based on the same common principle: to move heat away from the device to the ambient medium (in most cases air) by convection, conduction and radiation. Murshed SMS [3] produced Ecofriendly and low-cost water-based nano lubricants containing rutile TiO₂ nanoparticles (NPs) were developed for accelerating their applications in industrial-scale hot steel rolling. The lubrication performance of developed nano lubricants was evaluated in a 2-high Hille 100 experimental rolling mill at a rolling temperature of 850 °C in comparison to that of pure water. The results indicate that the use of nano lubricant enables one to decrease the rolling force, reduce the surface roughness and the oxide scale thickness, and enhance the surface hardness. Murshed SMS, Nieto de Castro CA, [4] presented development in semiconductor and other mini and micro scale electronic technologies and continued miniaturization have led to very high increase in power density for high performance chips. Nieto de Castro CA [5] The article focuses on the boiling heat transfer and droplet spreading behavior of nanofluids, which are mixtures of nanoparticles and base fluids that exhibit improved thermal properties compared to conventional fluids. The authors discuss the potential use of nanofluids in applications such

as heat pipes, refrigeration systems, and nuclear reactors. Murshed SMS and Nieto de Castro [6] As an emerging research field, nanofluids have sparked immense interest

from researchers around the world and have been a subject of intensive research in recent years. Because of their fascinating thermophysical properties and heat transfer performances, as well as enormous potential applications, nanofluids are considered the next generation heat transfer fluids. Murshed SMS and Nieto de Castro CA [7] Recent progresses in research on several key thermal features and potential applications of carbon nanotubes-laden nano-fluids are reviewed and addressed. Besides briefing on the preparation of these nanofluids, available studies on conduction, convection and boiling heat transfers of this specific class of nanofluids are discussed in detail. Effects of different parameters such as concentration of carbon nanotube and temperature on thermal conductivity, convective heat transfer coefficient, and boiling critical heat flux are also demonstrated. Wong VK and De Leon O [8] The article then goes on to review the current and potential future applications of nanofluids, including their use as heat transfer fluids, lubricants, and coolants in various mechanical systems. The authors also discuss the potential use of nanofluids in biomedical applications, such as drug delivery and cancer therapy, and in electronics, such as thermal management of microelectronic devices.

Research Methodology

CONVECTION

Convection is the process of heat transfer by the bulk movement of molecules within fluids such as gases and liquids. The initial heat transfer between the object and the fluid takes place through conduction, but the bulk heat transfer happens due to the motion of the fluid.

Convection is the process of heat transfer in fluids by the actual motion of matter. It happens in liquids and gases. It may be natural or forced. It involves a bulk transfer of portions of the fluid. When a fluid is heated from below, thermal expansion takes place. The lower layers of the fluid, which are hotter, become less dense. We know that colder fluid is denser. Due to Buoyancy, the less dense, hotter part of the fluid rises up. And the colder, denser fluid replaces it. This process is repeated when this part also gets heated and rises up to be replaced by the colder upper layer.

This is how the heat is transferred through convection.

There are two types of convection, and they are:

NATURAL CONVECTION

When convection takes place due to buoyant force as there is a difference in densities caused by the difference in temperatures it is known as natural convection. Examples of natural convection are oceanic winds.

RADIATION

The word "radiation" arises from the phenomenon of waves radiating (i.e., traveling outward in all directions) from a source. This aspect leads to a system of measurements and physical units that are applicable to all types of radiation is shown in below figure-1

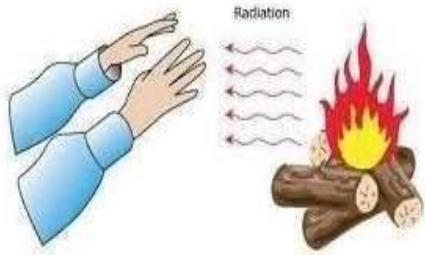


Fig.1 Radiation

BOUNDARY CONDITIONS

The boundary conditions of electronic chip is shown in below figures [2-3].

INLET

At the inlet the temperature taken as 45°C.

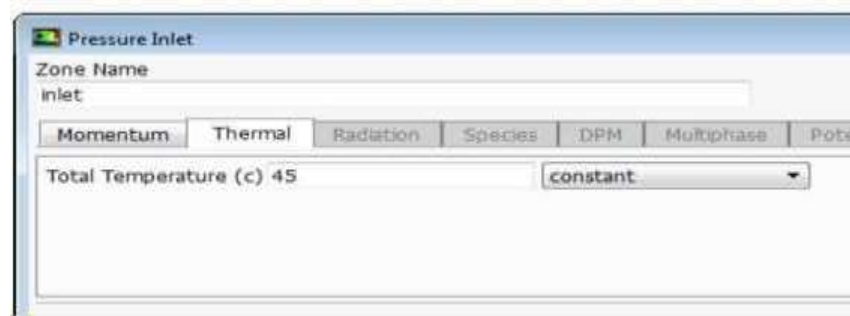


Fig.2 Pressure Inlet

OUTLET

At the OUTLET the gauge pressure is taken as zero.

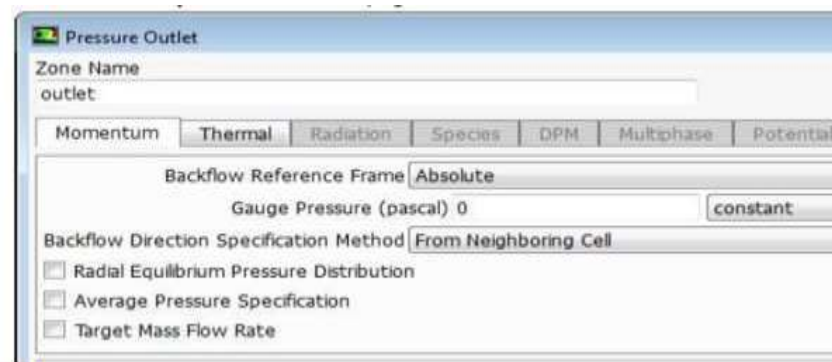


Fig.3 Pressure Outlet

Results and Discussion

CFD ANALYSIS CHIP USING COPPER (CU)

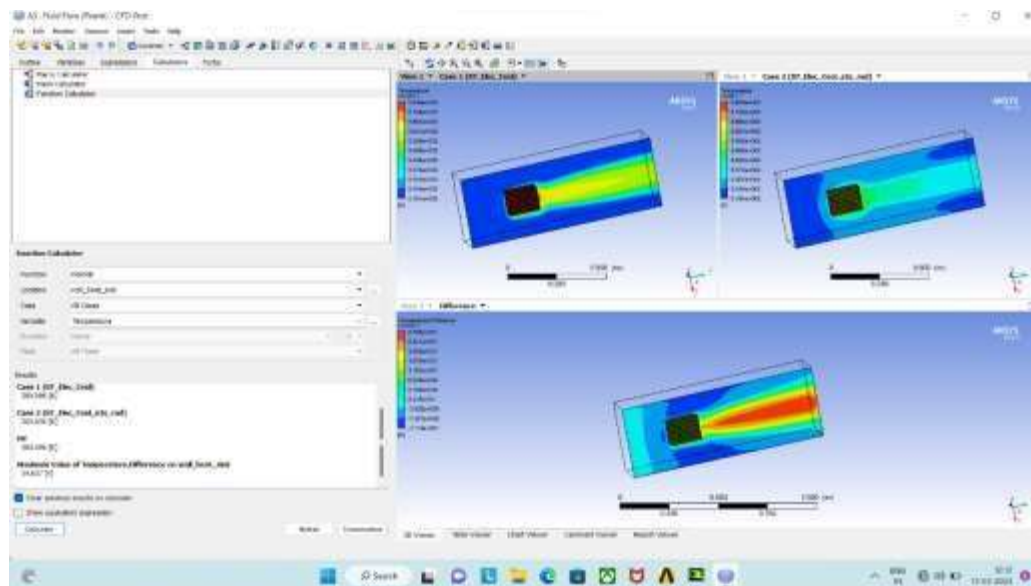


Fig.4 CFD Analysis for COPPER

CFD Analysis for copper is shown in the above figure 4. If copper has thermal conductivity is about 387.6 w/kg.k . If higher the thermal conductivity high heat transfer through the heat sink so the copper has heat transfer rate is about 364.5 k.

CFD ANALYSIS CHIP USING ALUMINIUM (AL)

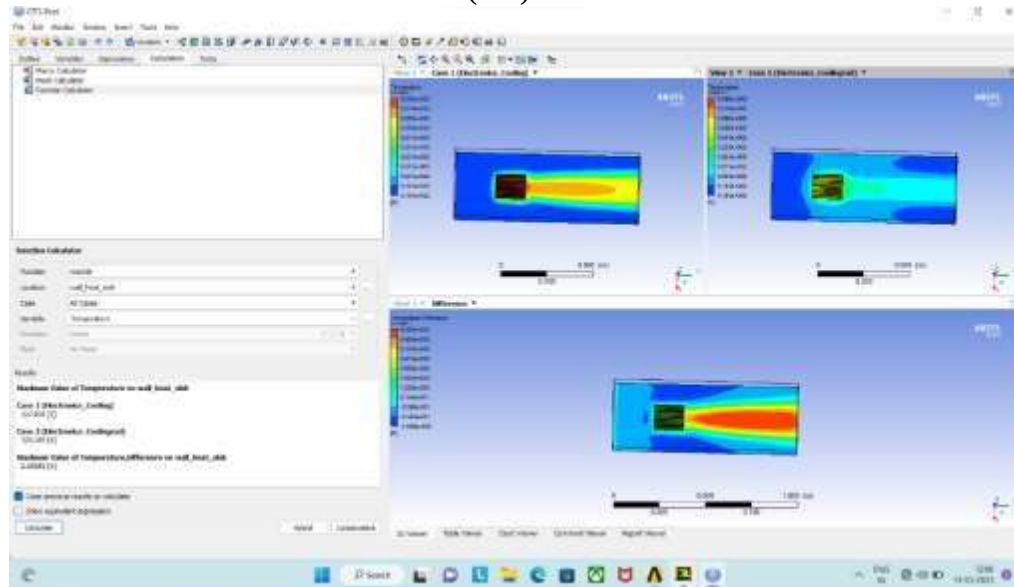


Fig.5 CFD Analysis for ALUMINIUM

CFD Analysis for ALUMINIUM is shown in the fig 5. If aluminum has thermal conductivity is about 241 w/kg.k . If higher the thermal conductivity high heat transfer through the heat sink so the aluminum has heat transfer rate is about 360 k.

Scaled Residuals

Copper

If scaled residuals contains continuity, x-velocity, y-velocity, z-velocity and energy. In this analysis we will find the energy variation up to 0.3 the due to the medium thermal conductivity as shown in below fig 6

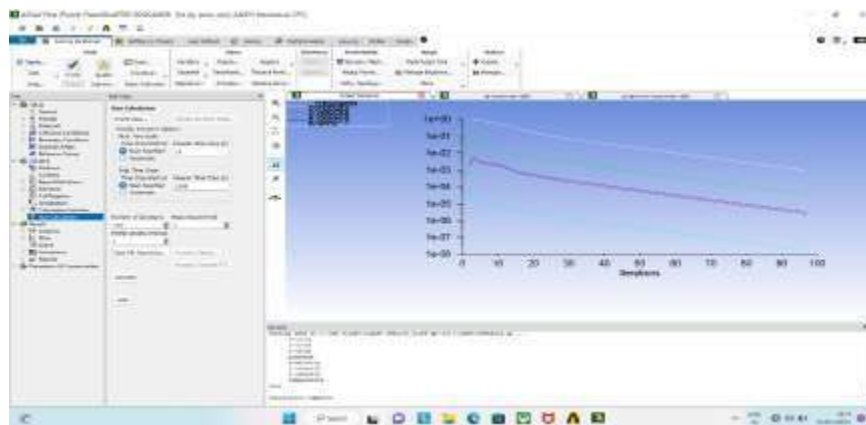


Fig.6 Scaled residuals for copper

ALUMINIUM

If scaled residuals contains continuity, x-velocity, y-velocity, z-velocity and energy. In this analysis we will find the energy variation up to 0.1 due to the less thermal conductivity when compare to copper as shown in below fig 7.

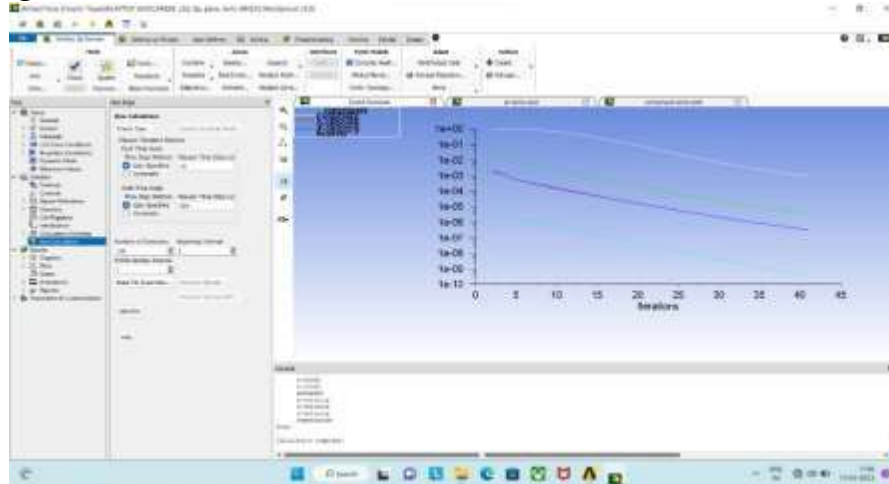


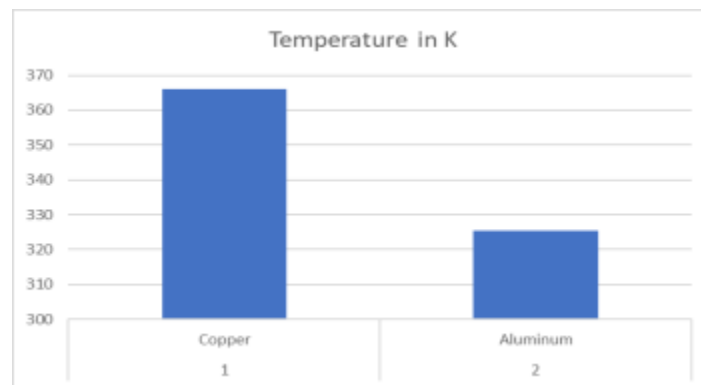
Fig.7 Scaled residuals for Aluminum

By using these values we will find out that if higher the thermal conductivity value, the higher the energy variation. By using those values copper has high energy variation as shown in graph1 and properties are given in table 1.

Result:

REMOVAL OF TEMPERATURE FROM CHIP

S.No.	Material	Temperature in K
1	Copper	365.936
2	Aluminum	325.355



Graph 1 removal of temperature from chip

Conclusion

Advances in electronics and semiconductor technologies have led to a dramatic increase in heat flux density for high-performance chips and components, whereas conventional cooling techniques and coolants are increasingly falling short in meeting the ever-increasing cooling need of such high heat-generating electronic devices or microprocessors. Despite good progress been made during the past decades, there remain

some serious technical challenges in thermal management and cooling of these electronics. High-performance chips and devices need innovative mechanisms, techniques, and coolants with high heat transfer capability to enhance the cooling rate for their normal performance and longevity. With superior thermal properties and cooling features, nanofluids offer great promises to be

used as coolants for hightech electronic devices and industries. The emerging techniques like microchannels with these new fluids can be the next-generation cooling technologies

References

1. Chang YW, Cheng CH, Wang JC and Chen SL. Heat pipe for cooling of electronic equipment. *Energy Conversion and Management*. 2008; 49(11):3398-3404.
2. Lasance C and Simons R. Advances in high-performance cooling for electronics. *Electronics Cooling*. 2005; 11(4):22-39
3. Murshed SMS, Leong KC, Yang C. Thermophysical and electrokinetic properties of nanofluids: a critical review. *Applied Thermal Engineering*. 2008; 28:2109-2125.
4. Murshed SMS, Nieto de Castro CA, Lourenço MJV, Lopes MLM and Santos FJV. A review of boiling and convective heat transfer with nanofluids. *Renewable and Sustainable Energy Reviews*. 2011; 15:2342-2354.
5. Murshed SMS and Nieto de Castro CA. Boiling heat transfer and droplet spreading of nanofluids. *Recent Patents on Nanotechnology*. 2013; 7:216-223.
6. Murshed SMS and Nieto de Castro CA. *Nanofluids: Synthesis, Properties, and Applications*. New York: Nova Science Publishers. 2014.
7. Murshed SMS and Nieto de Castro CA. Superior thermal features of carbon nanotubes based nanofluids: a review. *Renewable and Sustainable Energy Reviews*. 2014; 37:155- 167.
8. Wong VK and De Leon O. Applications of nanofluids: current and future. *Advances in Mechanical Engineering*. 2010; 2010: (ID 519659) 11.