Numerical Simulation on Ic Cooling with Water Based Tin, Tic And Sic Nanofluids

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Abstract*: In persistent consideration, CFD codes got established and executed with water based TiN, TiC and SiC nanofluids to envision the thermal alarms of ICs. The convective governing equalities of mass, force and drive are computed for envisaging the thermal issues of ICs. The time pace selected throughout the intact computation is 0.0001 s. The soundings affect CFD forecasts of temperature curve, temperature arena plus fluid-solid boundary temperature of IC. Corresponding fluid-solid boundaries temperatures of IC are viewed as 341, 310 and 319 K for water based TiN, TiC and SiC nanofluids, respectively. The temperature of water-TiC nanofluid stands peak contiguous to the IC locality as it stands far less than the chancy temperature limit of 356 K. Further, the temperature of water-TiC nanofluid gently drops with improvement in aloofness from IC. Afterwards, this becomes surrounding temperature in the distant arena precinct. The analogous tinted temperature curve stands accessible. Besides, the harmonizing graph of temperature against distance from IC stands revealed. Tritely, the evolution of CFD construal stay beside the aptitudes of deportments.

***Index Terms*: CFD Codes, Heat Dissipation, TiN, TiC and SiC Nanofluids.**

I. INTRODUCTION

A pointer of heat indulgences in preset devices from interconnects to server stay confirmed in figure 1. Electronics heat dissipation caught numerous routines for illustration.The standard heat dissipation arrayed heretofore for instance, atmospheric convection is inappropriate for extreme thermal flux treatments. Still, in the preceding years the strange way of heat dissipation has compelled the researchers' ubiquitously within the sphere for the humdrum of nanofluid heat control.

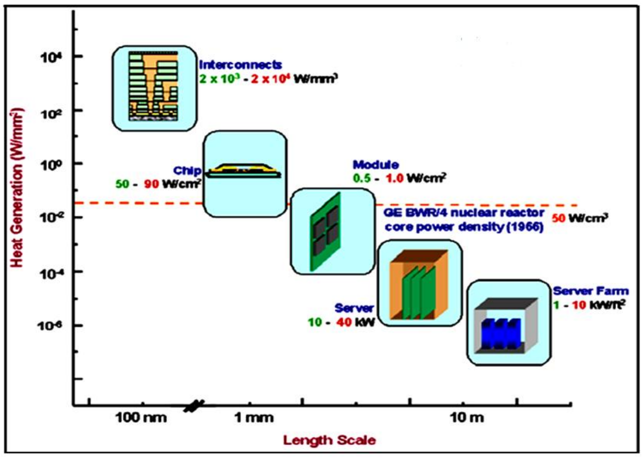

Figure 1. Progressive expansion of electronic devices

Furthermore, the nanofluid thermal dissipation is unequivocally spirited as ambient heat dissipation is poor to deliver the drive. Numerical and experimental reviews on heat spreading over rectangular domain are existent in texts [1-7]. Computational and experimental work with solidification also stand open [8-20].

However of the facts that the nanofluid cooling equivocates the issues about the extreme heat battle as to ambient heat dissipation and hence, the treatment of nanofluid remains the significant drive of the extant exploration. Here, the heat dissipations of electronics through water based TiN, TiC and SiC nanofluids stay spied mathematically.

II. DESCRIPTION OF PHYSICAL CHALLENGE

Figure 2 shows the physical topic course purview covering a heat generation from integrated circuit (IC) indicating the foot edge. Rest three edges are signposted through ambient situations. Here, the thermal controls of electronics is done through water based TiN, TiC and SiC nanofluids. Besides, the thermophysical and model data of nanoparticles reflected in the existent analysis plus the ambient situation involved in the current course computations, are briefed too in Table 1.

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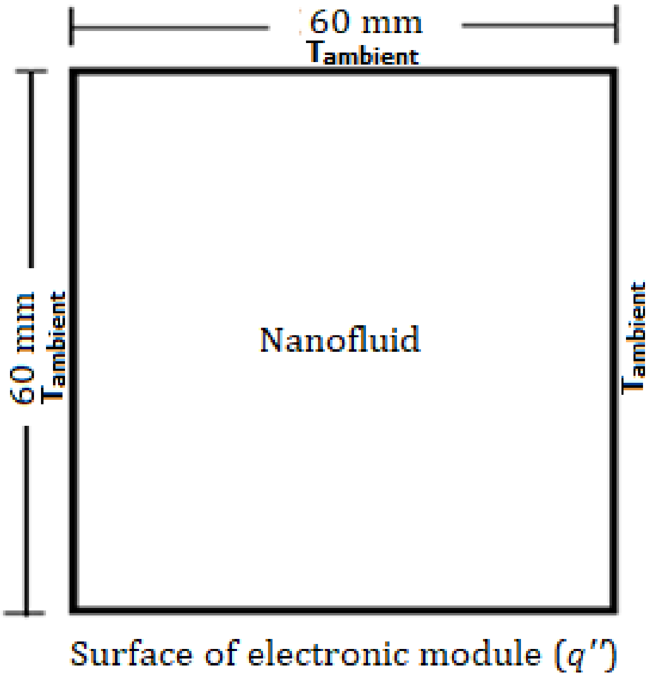

Figure 2. Graphical depiction of IC computational arena

Table 1. Thermophysical properties and model data.

Nanoparticle Properties	**TiN**	**TiC**	**SiC**
Density, ρ (Kg/m^3)	5431	4932	3162
Specific heat, C_P (J/kg.K)	602	712	676
Heat conductivity, k (W/m.K)	29	331	492
Model Data	**Values**		
Cavity size	60 mm		
IC size	60 mm		
Ambient temperature	300 K		
IC heat transfer rate/area	70 W/cm^2		

III. NUMERICAL PROCEDURE

As avowed above, the figure 2 reveals the CFD worktable aimed at computing the physical topic course. To facilitate the CFD forecasts the binding stages such as constructing geometry and purview, meshing and initialization are followed to run the simulation. Here, the prevailing equalities (as termed below through equalities 1-4) of mass, force and drive beside the edge states are chosen. Linearized equalities are computed through the CFD codes. After the development of computations, CFD codes form the shapes and curls through that numerous graphs stand strained to amalgam the CFD forecasts through the prognoses. With the later dispensation the forecasts are scrupulously explored aimed at receiving abundant acumens.

Continuity: $$\frac{\partial u}{\partial x}+\frac{\partial v}{\partial y}=0 \quad (1)$$

X-momentum:

$$\rho\left(\frac{\partial u}{\partial t}+u\frac{\partial u}{\partial x}+v\frac{\partial v}{\partial y}\right)=-\frac{\partial p}{\partial x}+\mu\left(\frac{\partial^2 u}{\partial x^2}+\frac{\partial^2 u}{\partial y^2}\right) \quad (2)$$

Y-momentum:

$$\rho\left(\frac{\partial v}{\partial t}+u\frac{\partial v}{\partial x}+v\frac{\partial v}{\partial y}\right)=-\frac{\partial p}{\partial y}+\mu\left(\frac{\partial^2 v}{\partial x^2}+\frac{\partial^2 v}{\partial y^2}\right)+\rho g\beta\Delta T \quad (3)$$

Energy:

$$\left(\frac{\partial T}{\partial t}+u\frac{\partial T}{\partial x}+v\frac{\partial T}{\partial y}\right)=\alpha\left(\frac{\partial^2 T}{\partial x^2}+\frac{\partial^2 T}{\partial y^2}\right) \quad (4)$$

In the existent analysis, CFD codes are developed and executed with water based TiN, TiC and SiC nanofluids to visualize the thermal concerns of ICs. The convective governing equalities of mass, force and drive are computed for envisaging the thermal issues of ICs. The time pace selected throughout the intact computation is 0.0001 s.

IV. RESULTS AND DISCUSSIONS

CFD codes are developed and executed with water based TiN, TiC and SiC nanofluids. It envisages the impacts on thermal control of ICs. The soundings affect CFD forecasts of temperature curves, temperature arenas plus fluid-solid boundaries temperatures of ICs.

Effect of Water-TiN Nanofluid on IC Heat Dissipation

Figure 3 discloses the CFD prognosis of temperature arena besides the tinted measuring scale screening the temperature values over K. It stands viewed at the documented archetype statuses bearing in mind the water-TiN nanofluid for IC heat dissipation. The fluid-solid boundary temperature of IC is viewed as 341 K. This stands far less than the chancy limit of 356 K temperature wished for the objective of outwitting thermal cataclysm of IC. The temperature of water-TiN nanofluid stands peak contiguous to the IC locality.

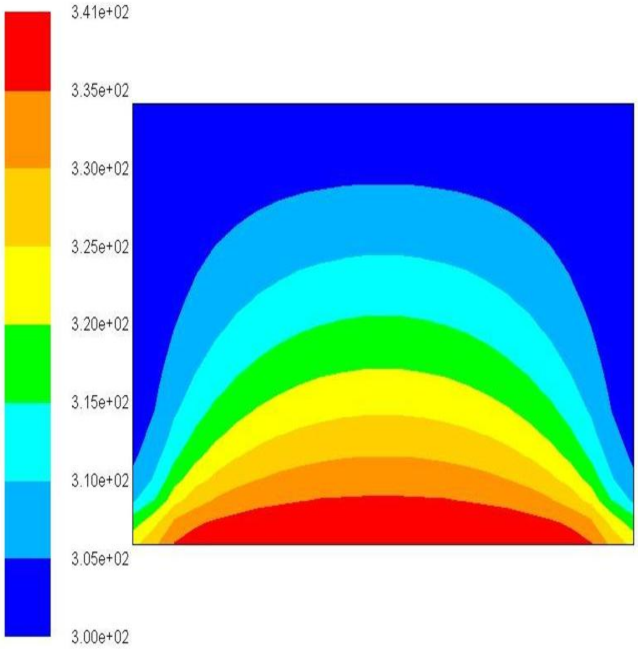

Figure 3. Temperature field with water-TiN nanofluid

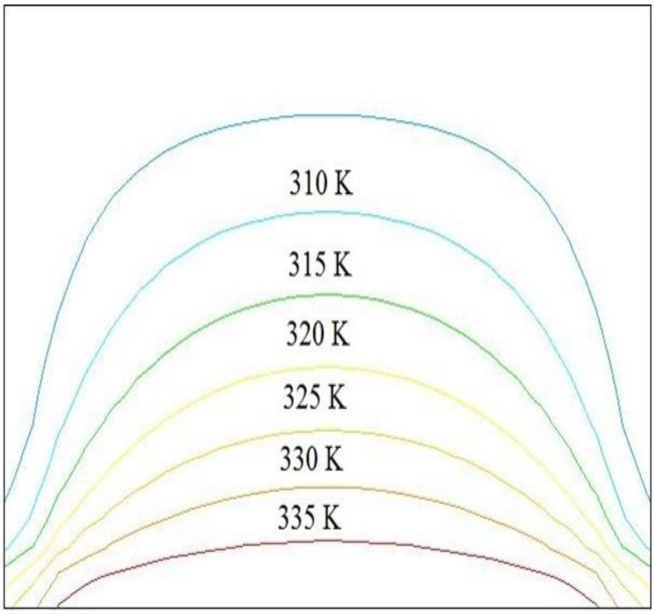

Figure 4. Temperature contour with water-TiN nanofluid

Further, the temperature of water-TiN nanofluid gently drops with improvement in aloofness from IC. Afterwards, this becomes surrounding temperature in the aloof arena precinct. The equivalent tinted temperature curve stands accessible in figure 4 on top.

Effect of Water-TiC Nanofluid on IC Heat Dissipation

Figure 5 discloses the CFD prognosis of temperature arena besides the tinted measuring scale screening the temperature values over K. It stands viewed at the documented archetype statuses bearing in mind the water-TiC nanofluid for IC heat dissipation. The fluid-solid boundary temperature of IC is viewed as 310 K. This stands far less than the chancy limit of 356 K temperature wished for the objective of outwitting thermal cataclysm of IC.

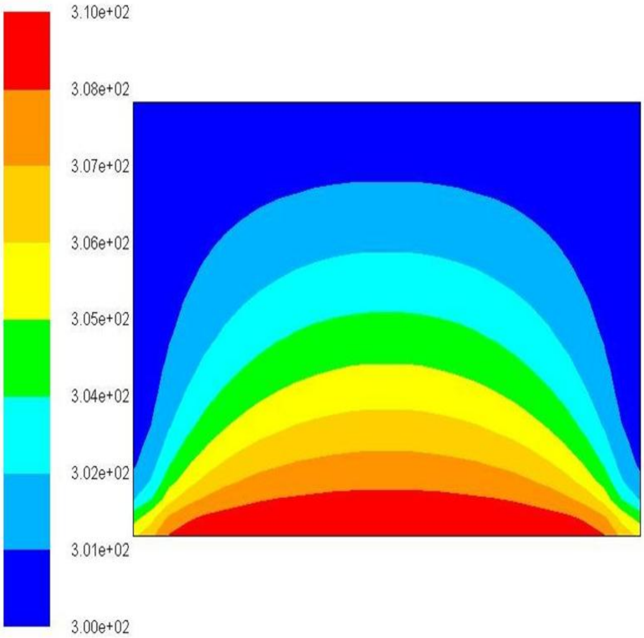

Figure 5. Temperature field with water-TiC nanofluid

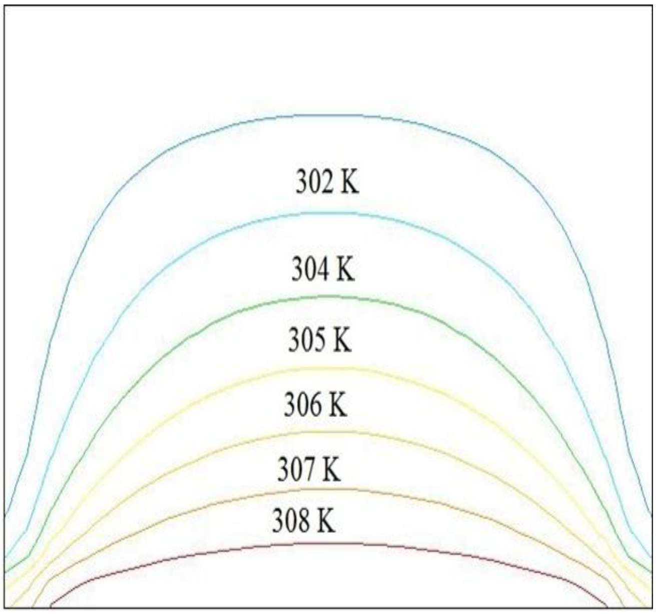

Figure 6. Temperature contour with water-TiC nanofluid

Tritely, the temperature of water-TiC nanofluid stands peak contiguous to the IC locality. Further, the temperature of water-TiC nanofluid gently drops with improvement in aloofness from IC. Afterwards, this becomes surrounding temperature in the aloof arena precinct. The equivalent tinted temperature curve stands accessible in figure 6 on top.

Impact of Water-SiC Nanofluid on IC Heat Dissipation

Figure 7 reveals the CFD forecast of temperature arena besides the tinted measuring scale screening the temperature values over K.

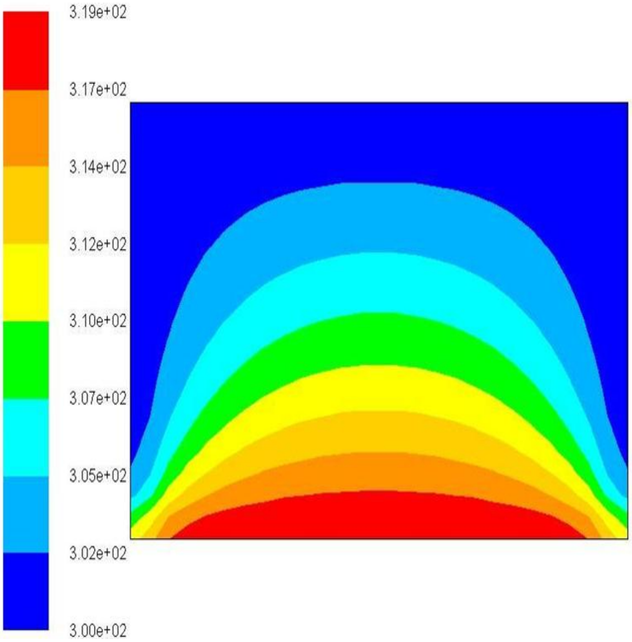

Figure 7. Temperature field with water-SiC nanofluid

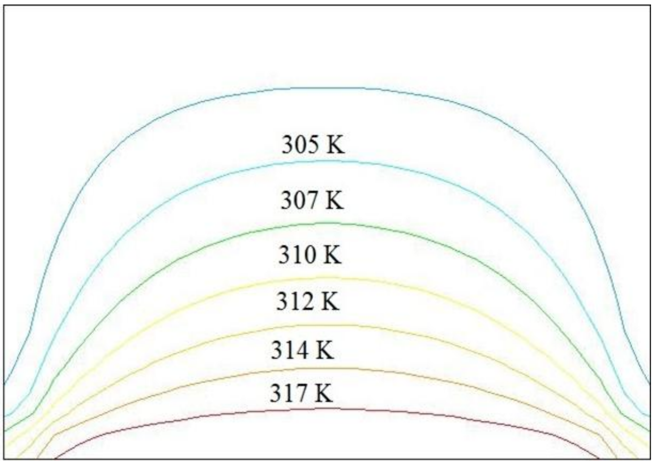

Figure 8. Temperature contour with water-SiC nanofluid

It stands viewed at the documented archetype statuses bearing in mind the water-SiC nanofluid for IC thermal control. The fluid-solid boundary temperature of IC is viewed as 319 K. This stands far less than the chancy limit of 356 K temperature wished for the objective of outwitting thermal cataclysm of IC. Tritely, the temperature of water-SiC nanofluid stands peak contiguous to the IC locality. Further, the temperature of water-SiC nanofluid gently drops with improvement in aloofness from IC. Afterwards, this becomes surrounding temperature in the distant arena precinct. The analogous tinted temperature curve stands accessible in figure 8 on top.

Table 2 agglomerates the fluid-solid boundaries temperatures of ICs observed with water based TiN, TiC and SiC nanofluids.

Though the trends of fields/contours results are similar, however, the discrepancies are owing to the variations in the thermophysical properties of the related nanoparticles as summarized in table 1. Figure 9 exhibits the corresponding graph of IC temperature versus nanofluid.

Table 2. Summary of IC temperatures along with nanofluids.

Nanofluid	IC Temperature (K)
Water-TiN	341
Water-TiC	310
Water-SiC	319

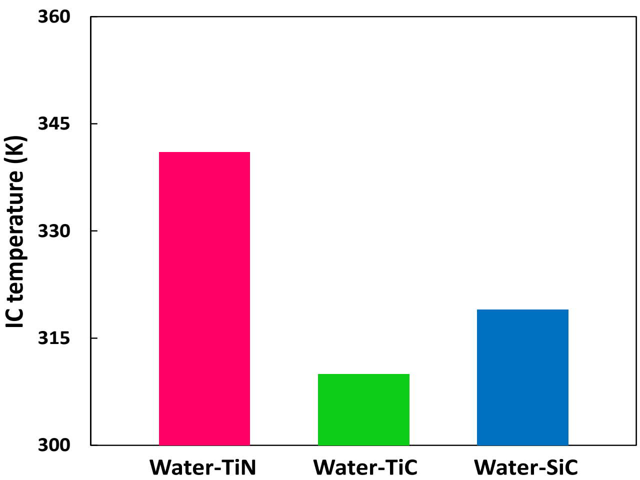

Figure 9. IC temperature vs. nanofluid

V. CONCLUSION

In tenacious contemplation, CFD codes are developed and performed with water based TiN, TiC and SiC nanofluids to envision the thermal alarms of ICs. The convective governing equalities of mass, force and drive are computed for envisaging the thermal issues of ICs. The time pace selected throughout the intact computation is 0.0001 s. The soundings affect CFD forecasts of temperature curve, temperature arena plus fluid-solid boundary temperature of IC. Corresponding fluid-solid boundaries temperatures of IC are viewed as 341, 310 and 319 K for water based TiN, TiC and SiC nanofluids, respectively. The temperature of water-TiC nanofluid stands peak contiguous to the IC locality as it stands far less than the chancy temperature limit of 356 K. Further, the temperature of water-TiC nanofluid gently drops with improvement in aloofness from IC. Afterwards, this becomes surrounding temperature in the distant arena precinct. The analogous tinted temperature curve stands accessible. Besides, the harmonizing graph of temperature against distance from IC stays exposed. The development of CFD analysis stand alongside the propensities of postures.

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Dr. N. K. Kund has obtained both M.Tech. & Ph.D. in Mechanical Engineering from Indian Institute of Science Bangalore. He has also obtained B.Tech.(Hons) in Mechanical Engineering from IGIT Sarang, Utkal University Bhubaneswar. He has published several research papers in international journals and also guided many research scholars, besides, wide teaching and research experience. He is presently working as Associate Professor in the Department of Production Engineering, VSSUT Burla (A Government Technical University).