

# Nano Die Attach Material Used in High Power Electronic Device Package

Be-Nazir khan and James Archibald

UML, IXYSICD

# Objective/Purpose of Interest

- To keep the temperature lower in electronic packaging
- To obtain lower thermal resistance in electronic packaging
- To choose the Pb-free die attach material in power electronic packaging

# Why Material is Important in Thermal Management?

- To achieve better thermal performance of wide band gap semiconductors(WBG) --- SiC, GaN to operate at high temperature
- To keep lower thermal resistance in power electronics to operate at higher temperature.
- Die attach material plays a key role in thermal management of the IC packaging in power electronics.

# High temperature die attach material

- High temperature application of die attach material is required in SiC or other wide band gap based electronic package.
- Gold-germanium(Au-Ge), nanoscale silver, bismuth-silver system are high temperature and Pb-free die attach materials
- Nano-Ag die attach material plays an important role because of good thermal and electrical conductivity.

# Description of the IC-Package

- Semiconductor based direct copper bond(DCB) package consists of Si or SiC with different types of die attach materials.

# Different types of Die Attach Materials

- Nano-Ag
- 88%Au12%Ge
- 58%Bi42%Sn
- 90%Pb10%Sn

# IC-Package

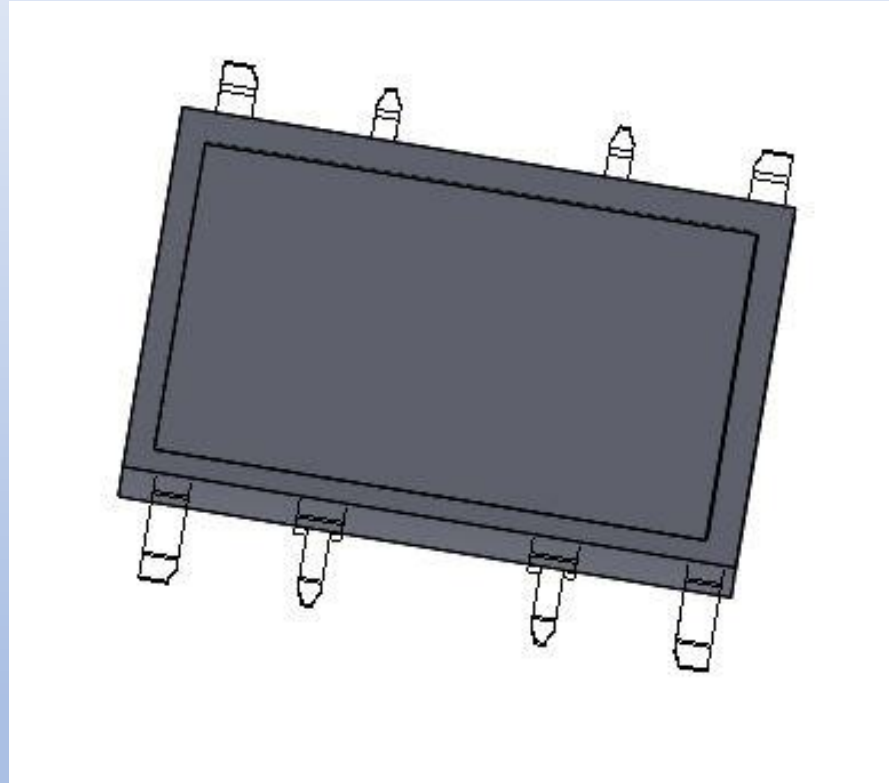


Figure: IC-Package Model

# Computational Fluid Dynamics Modeling

- Computational fluid dynamics based thermal modeling and simulation of electronic packaging is developed with different types of die attach materials to identify the hotspot of the electronic component.



# Materials

Electronic Package Materials	Material	Thermal conductivity (W/m-K)
Die	Silicon	150.00
	SiC	430.00
Die attach	Nano-Ag sintered epoxy	240.00
	88% Au12% Ge	44.00
	58% Bi42% Sn	19.00
	90% Sn10% Pb	35.80
Substrate	AlN	200
Lead frame	Copper	160
Encapsulation	Epoxy mold compound	0.9

# Thermal Profile

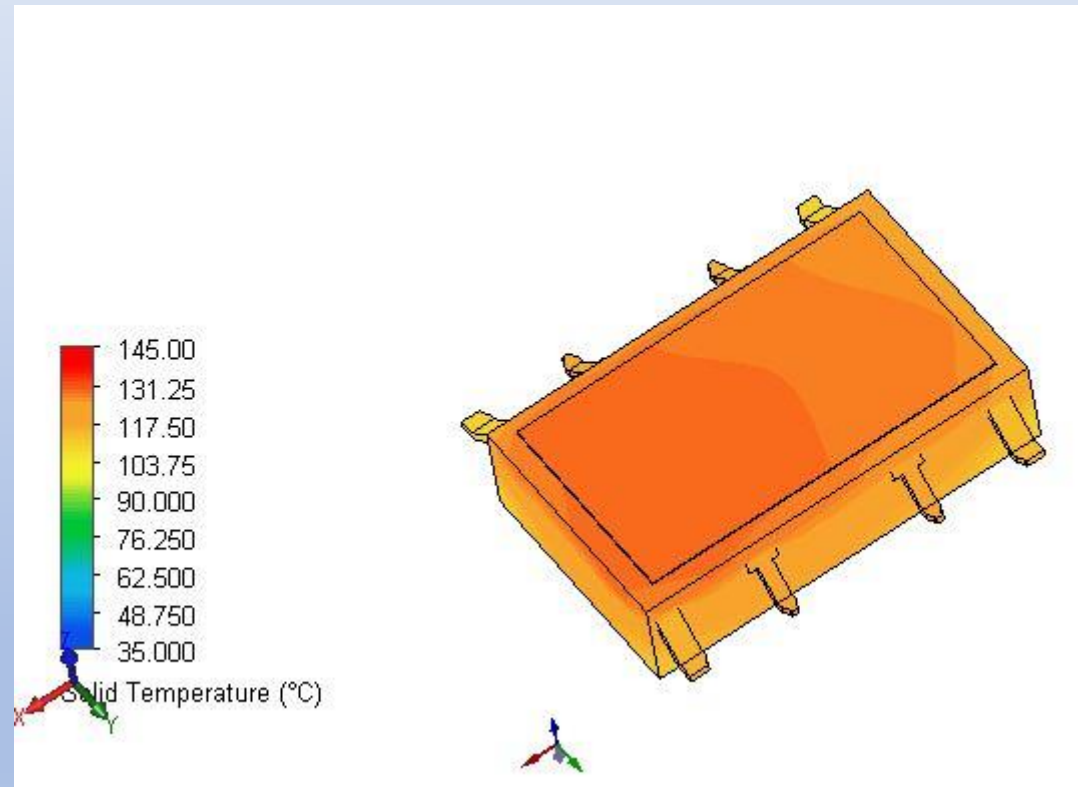


Figure: Thermal Profile of Si based IC packaging

# Thermal Profile

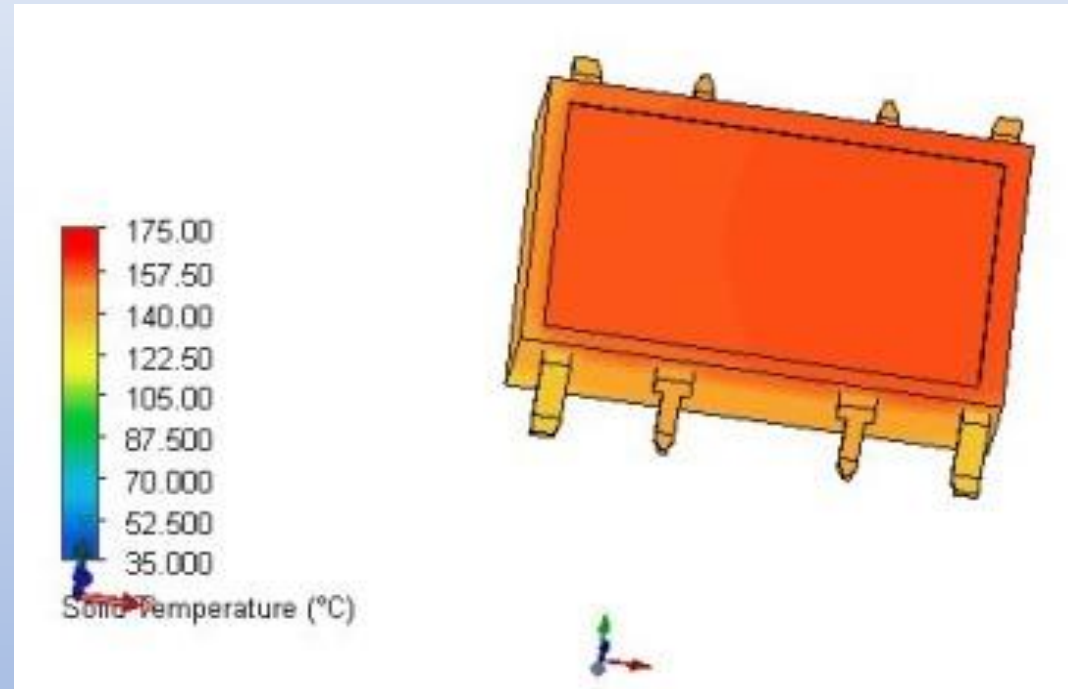


Figure: Thermal Profile of SiC based IC packaging

# Direct Copper Bond(DCB)

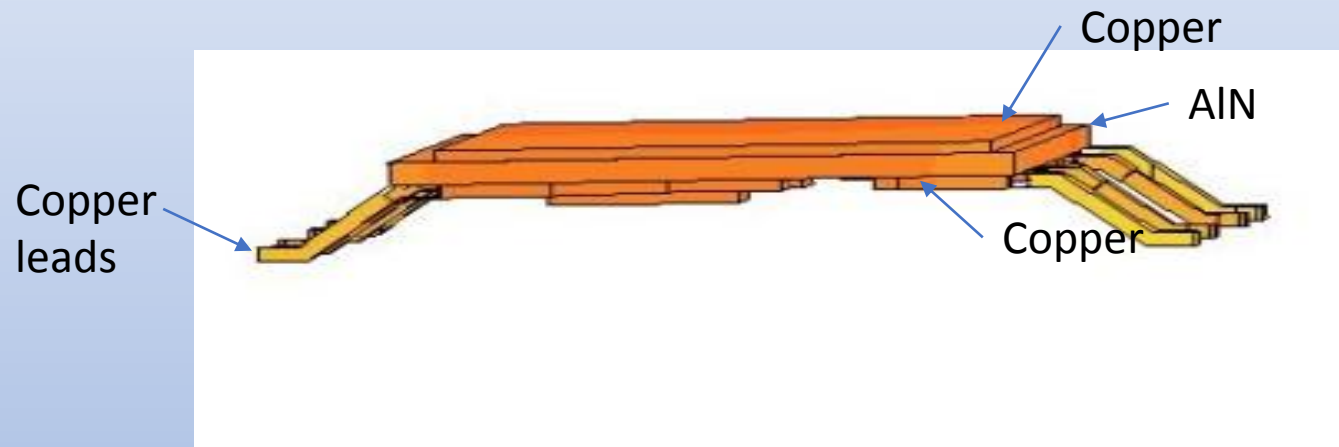


Figure: DCB structure

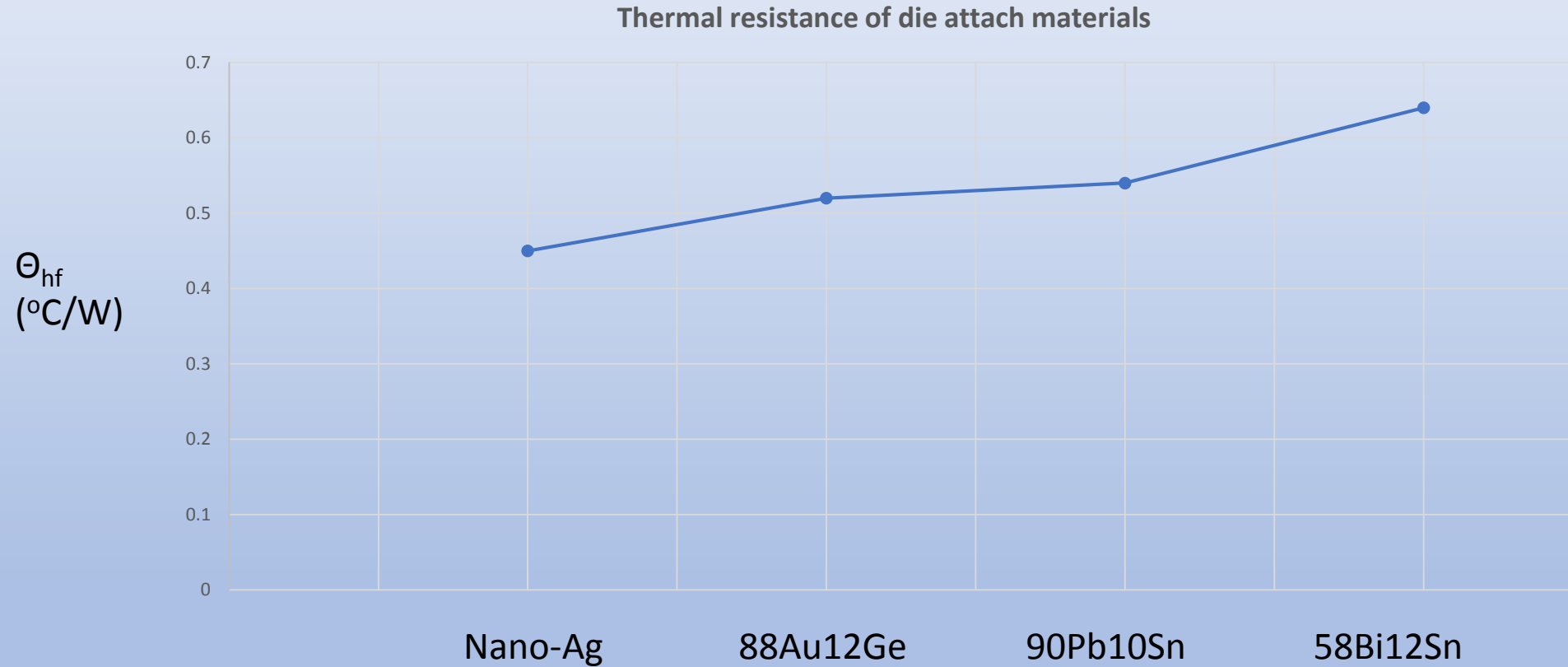
# Heat Transfer

- Computational fluid dynamics based IC packaging thermal modeling and simulation tool is used to consider both conduction and convection level heat transfer flow from die level hotspot to natural still air fluid.

# Thermal Resistance

- Theta-hf ( $\Theta_{hf}$ ) : Thermal resistance between hotspot and maximum fluid temperature is generated for different die attach materials used in IC packaging

# Thermal resistance of die attach materials



# Conclusion

- It is found that the nano-Ag die attach material has better thermal performance than other die attach materials. The thermal model of the nano-Ag die attached package shows lower thermal resistance.
- To make the product reliable in operating environment, hot spot thermal management of IC packaging of power electronics is one of the most important criteria.
- Nano-Ag die attach based SiC package will not only serve the Pb-free high-temperature requirement but also shows lower thermal resistance.



# Acknowledgements

I would like to express my sincere acknowledgements and appreciation to IXYSICD on this with approval.

Thank You!