April 30, 2025

Honey, I Shrunk the Stack

Reducing The Thermal Stack with TIM 1.5

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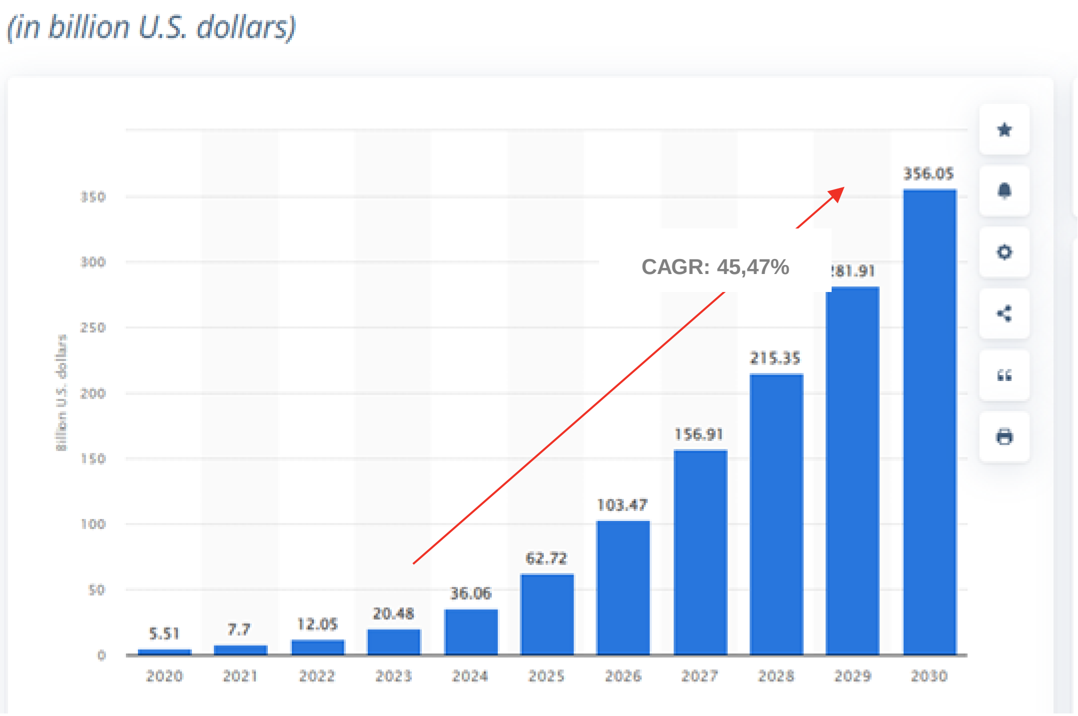
GROWTH IN GLOBAL
GENERATIVE AI WILL GROW TEN-FOLD BY 2030

Megatrend-Generative AI Worldwide Market Size



Note: Data shown is using current exchange rates, Mar 2024.
Source: Statista Market Insights.

AI Chips Used in Multiple Applications

- **Autonomous Vehicles:** AI chips power real-time decisions required by autonomous vehicles.
- **Healthcare:** AI chips enable faster and more accurate diagnosis through medical imaging, drug discovery, and personalized medicine.
- **Smart Devices:** AI chips are at the core of intelligent features like voice recognition, image processing, and predictive analytics.
- **Cloud Computing:** Cloud-based AI platforms allow businesses to access powerful AI computing without investing in their own hardware.
- **Robotics:** AI chips provide the computational power necessary for tasks like object recognition, real-time decision-making, and human-robot interaction.

AI CHIPS ENABLING ADVANCED APPLICATIONS

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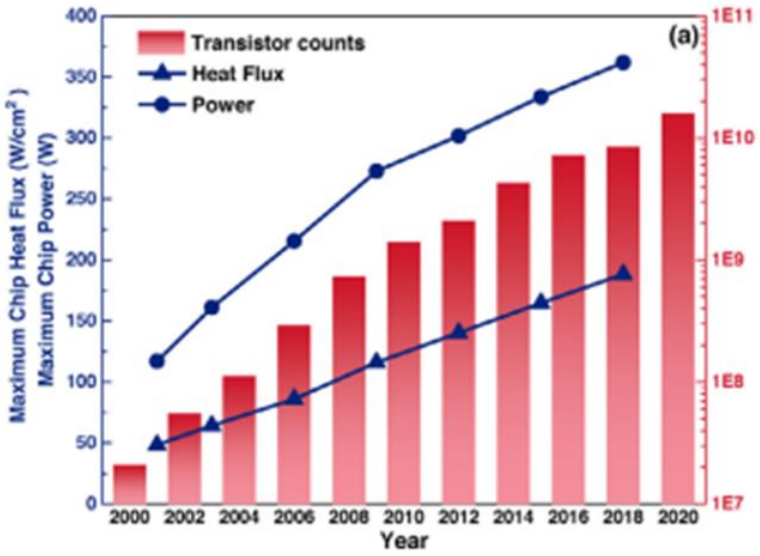
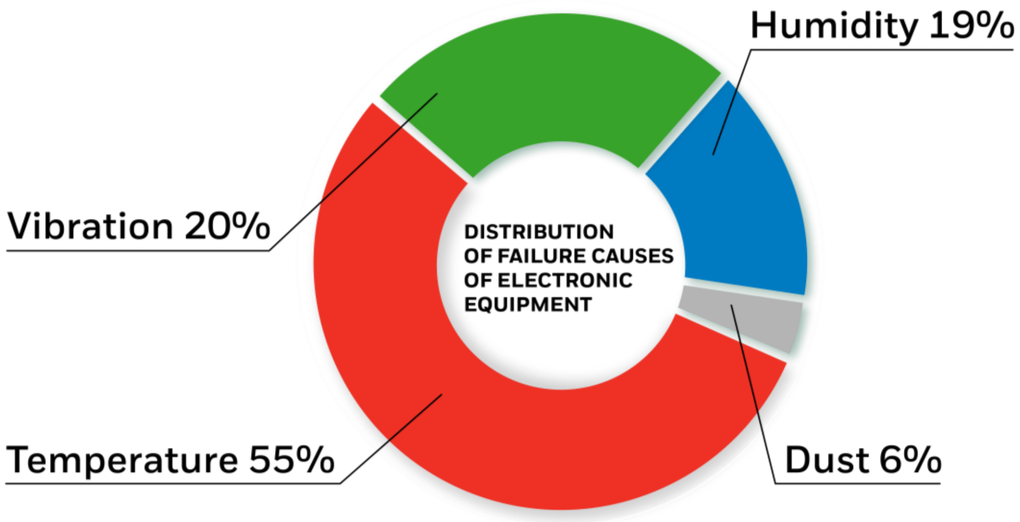
AI CHIPS
GETTING "HOTTER"

- Rapid advancements in semiconductor technology, leading to smaller transistors, higher clock speeds, and increased integration density key to AI chips.
- Programmable logic capacity has grown 2-3X every 2-3 years and use of chiplet design for CPU/GPU in high performance computing and AI data center applications is becoming the norm.
- The heat flux generated by chips has steadily increased significantly resulting in more power dissipation within a smaller area.





Source: e-Prime, Vol. 1, 2021

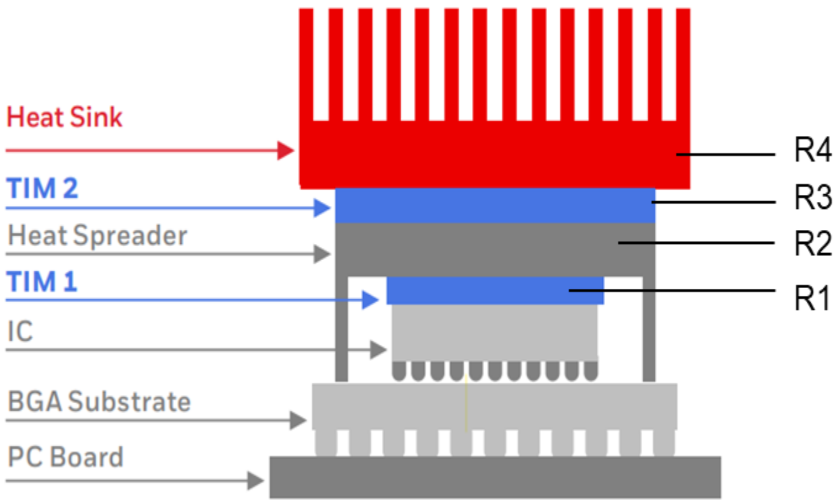
(a) The development trend of chip maximum power consumption, heat flux density, and approximate transistor counts in the past 20 years

(b) Distribution of failure causes of electronic equipment

TEMPERATURE - RELATED FAILURES INCREASING IN ADV. NODE CHIPS

HEAT MANAGEMENT IN AI CHIPS
TIM 1.5 – SHRINKING THE STACK

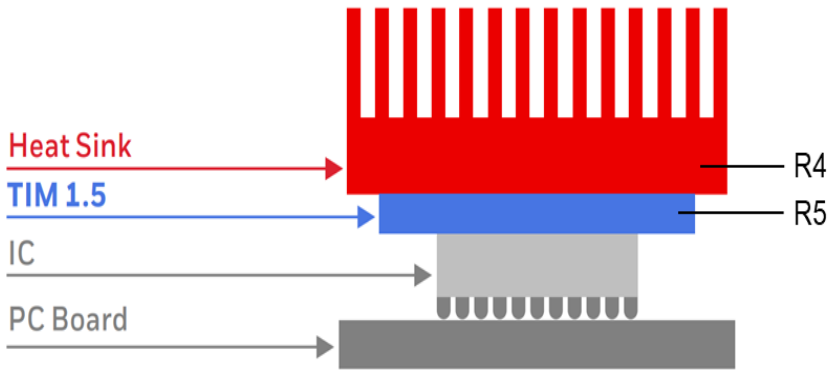
Traditional Design with TIM 1, IHS, and TIM 2



Total Thermal Resistance btw IC and environment: **R=R1+R2+R3+R4**

- **TIM 1** is placed between the chip or die and the integrated heat spreader.
- **TIM 2** is placed between the heat spreader and heat sink.

New Design with TIM 1.5



Total Thermal Resistance btw IC and environment: **R=R5+R4**

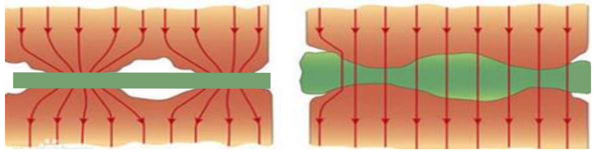
- **TIM 1.5** is placed between the chip and the heat sink.

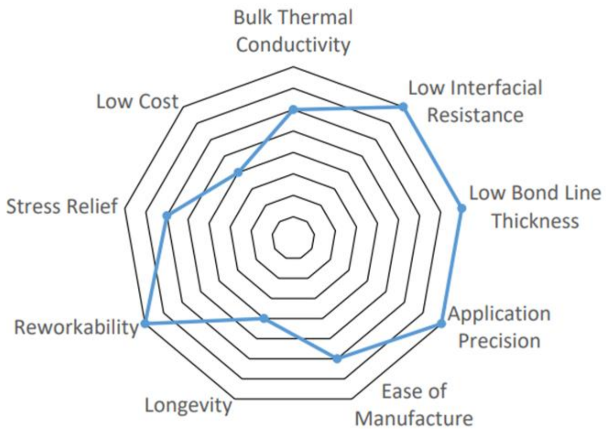
Shrinking the Stack – TIM 1.5 - Reducing Total Thermal Resistance

A VARIETY OF TIMS
TO CHOOSE FROM FOR TIM 1.5

Property	Gap Pads	Gap Fillers	Thermal Grease	Phase Change Materials (PCMs)	Adhesive Tapes	Potting / Encapsulants	Liquid Metals
Bulk Thermal Conductivity	Excellent	Good	Excellent	Good	Fair	Fair	Excellent
Low Interfacial Resistance	Fair	Good	Good	Excellent	Poor	Excellent	Excellent
Low Bond Line Thickness	Poor	Good	Poor	Excellent	Fair	Good	Poor
Application Precision	Excellent	Poor	Poor	Excellent	Excellent	Poor	Poor
Ease of Manufacture	Good	Fair	Poor	Good	Good	Fair	Good
Longevity	Fair	Fair	Poor	Fair	Fair	Fair	Fair
Reworkability	Excellent	Good	Good	Excellent	Poor	Good	Fair
Stress Relief	Good	Excellent	Poor	Good	Fair	Fair	Good
Low Cost	Good	Good	Excellent	Fair	Good	Good	Poor

PCM fill in the microscopic air gaps between surfaces (IC/Heat Sink)





Relative Performance of PCM

SELECTION BASED ON TIM PERFORMANCE & DEVICE DESIGN CONSTRAINTS

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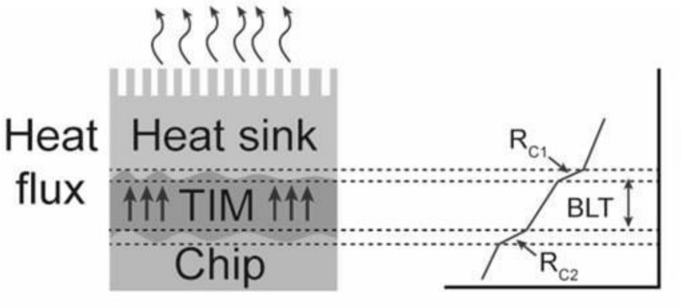
THERMAL NEEDS OF AI APPLICATIONS

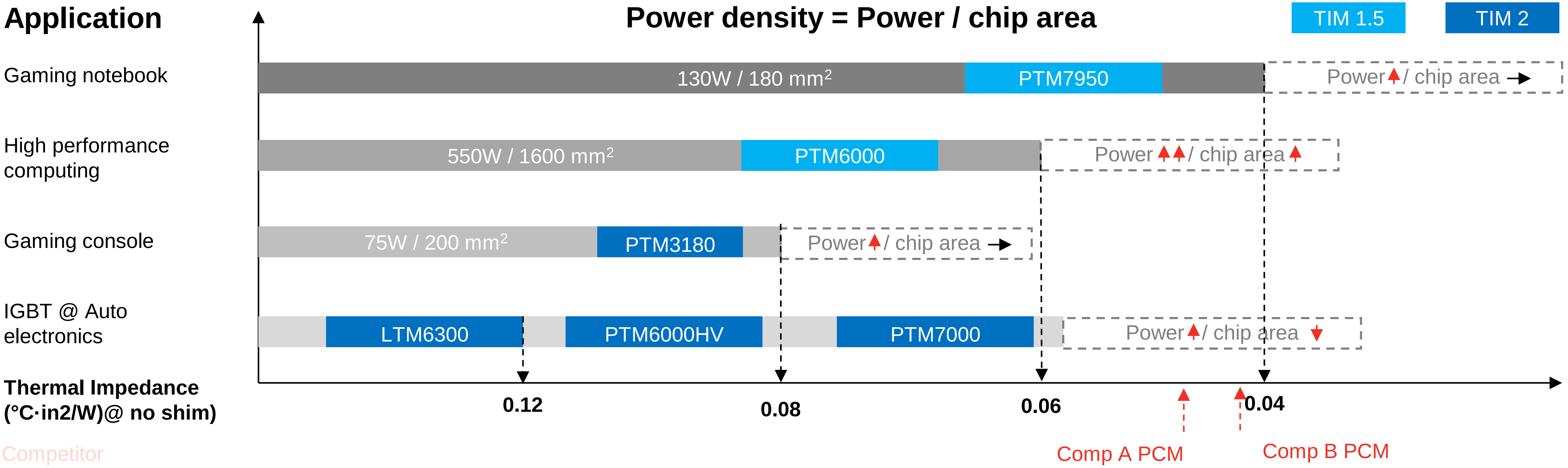
BLT< ~200-300um

PCM & Grease



BLT> ~200-300um

Gap pad, hybrid gap filler



AI APPLICATIONS HAVE HIGH POWER DENSITY & LOW BLT

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THANK YOU