A New Method for Bonding: Room Temperature Soldering

Advancing Industrial Joining with Nanotechnology

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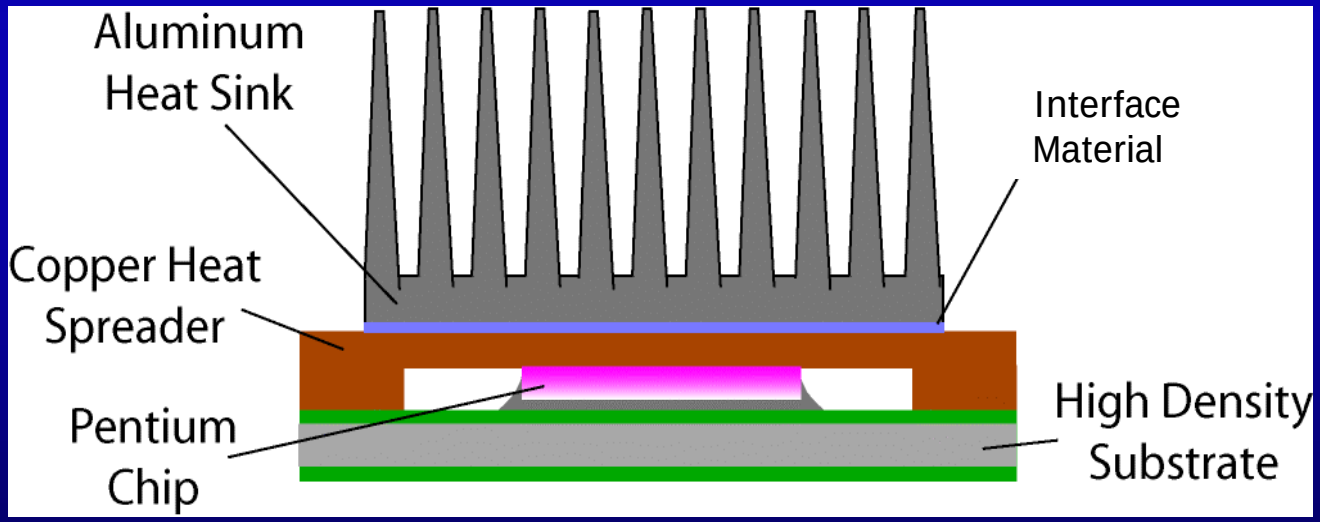
Industrial Joining Problems

- Low Conductivity and Durability (adhesives)
  - Poor thermal conduction, low strength
  - Degrade over time due to air and sun light
- Thermal Damage (furnace soldering and brazing)
  - Temperature-sensitive components cannot be soldered
  - Joints fail due to thermal mismatch on cooling

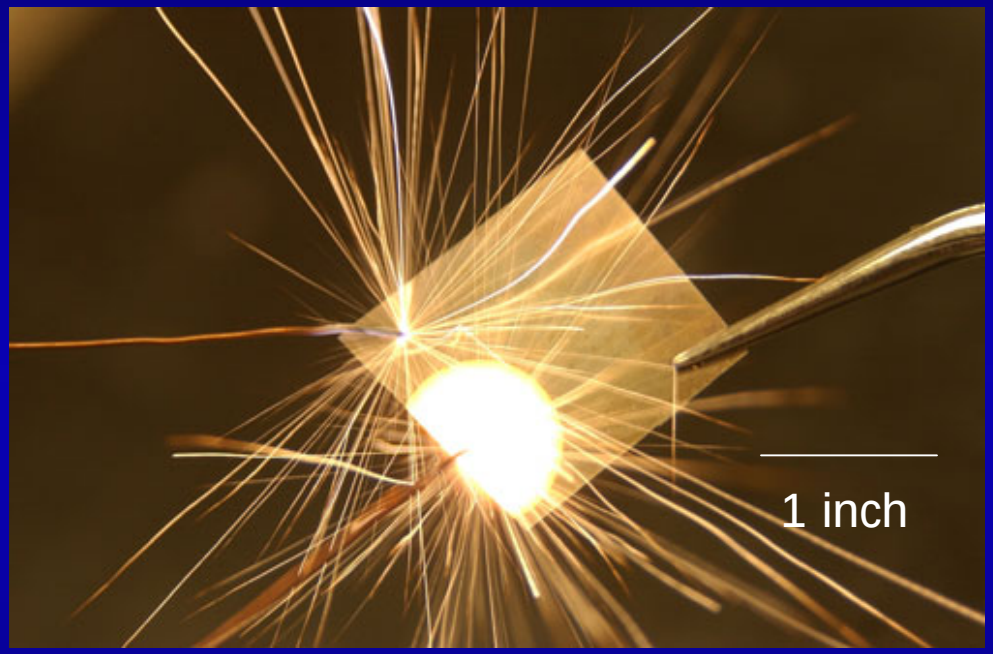
A Case Study

"Heat is becoming one of the most critical issues in computer and semiconductor design," warns Intel's CTO Pat Gelsinger.

How does one form a metallic solder interface without damaging the chip?



RNT's Solution



RNT's NanoFoil™: the world's first nanoengineered, computer designed, localized heat source

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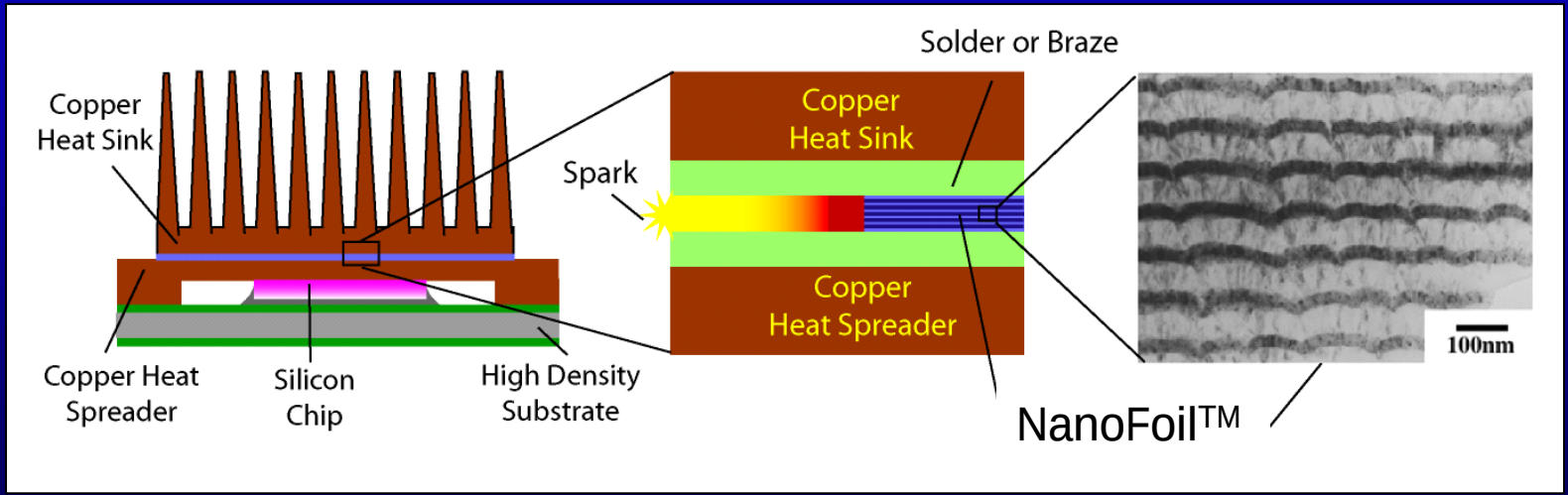
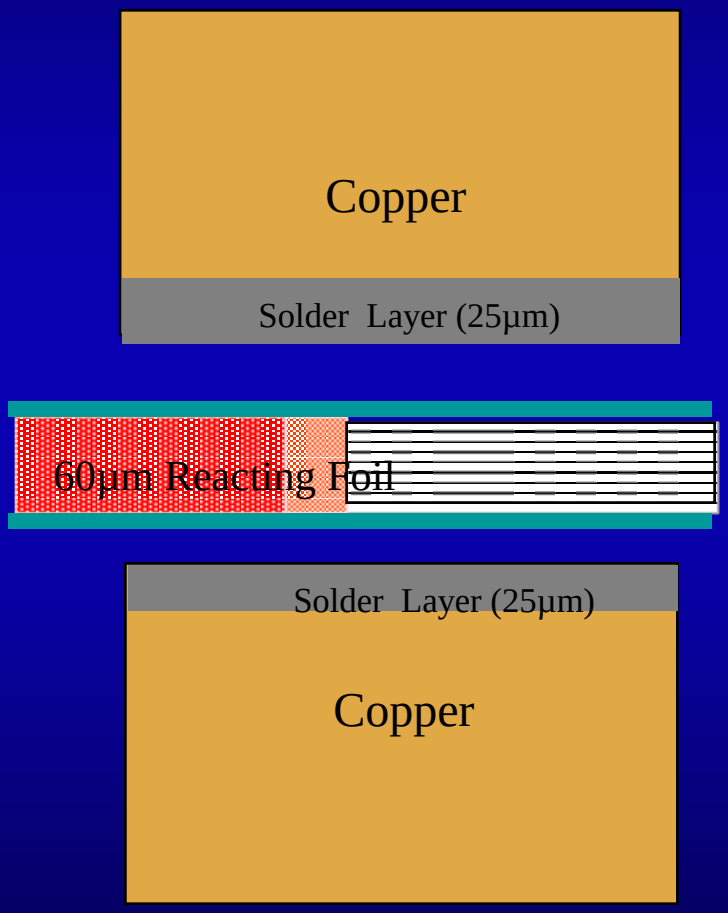
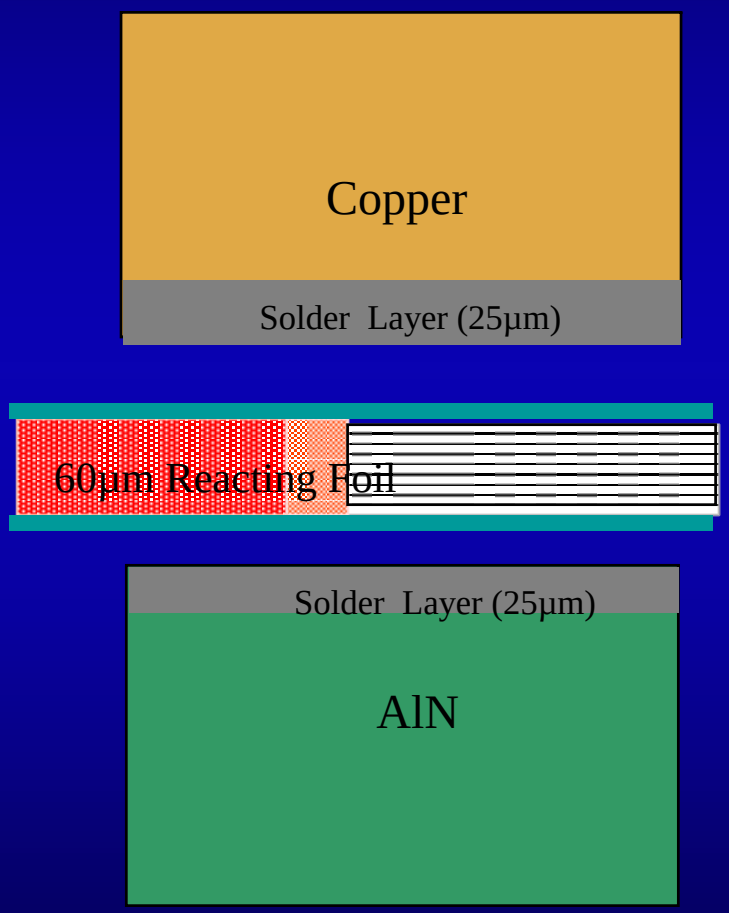
The Technology

- NanoFoil™
  - A foil with thousands of nanoscale layers
  - A controllable, rapid heat source (computer designed)
- NanoBond™
  - A proprietary, room temperature bonding method
  - Can use any commercial solder or braze
  - Does not require fluxes or special environment



NanoBonding™: Cu/Cu and Cu/AlN





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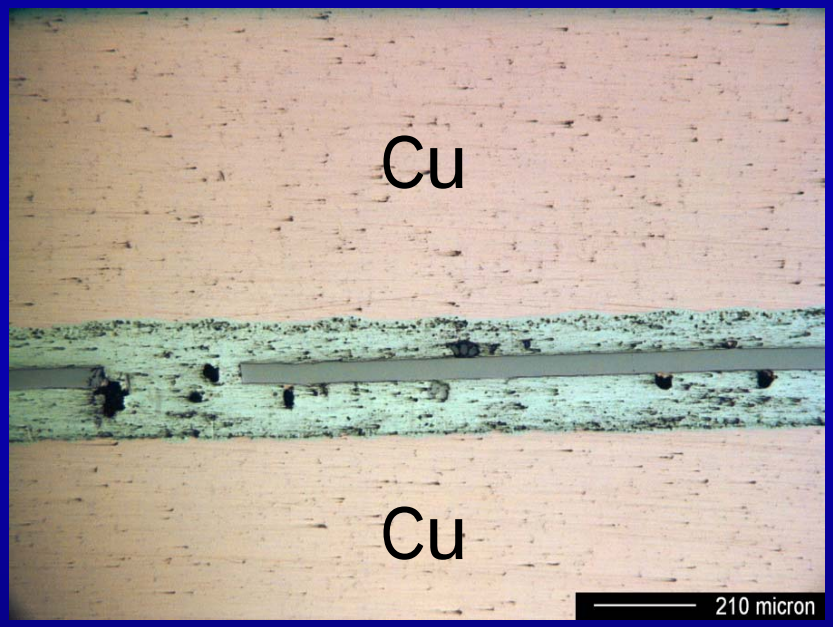
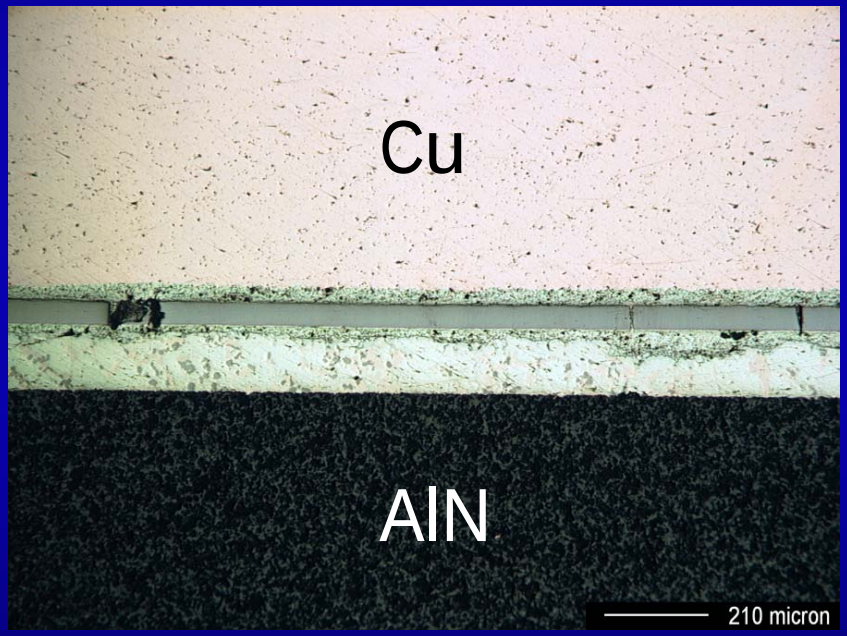
NanoBonding™: Cu/Cu and Cu/AlN

Cu to Cu



Cu to AlN



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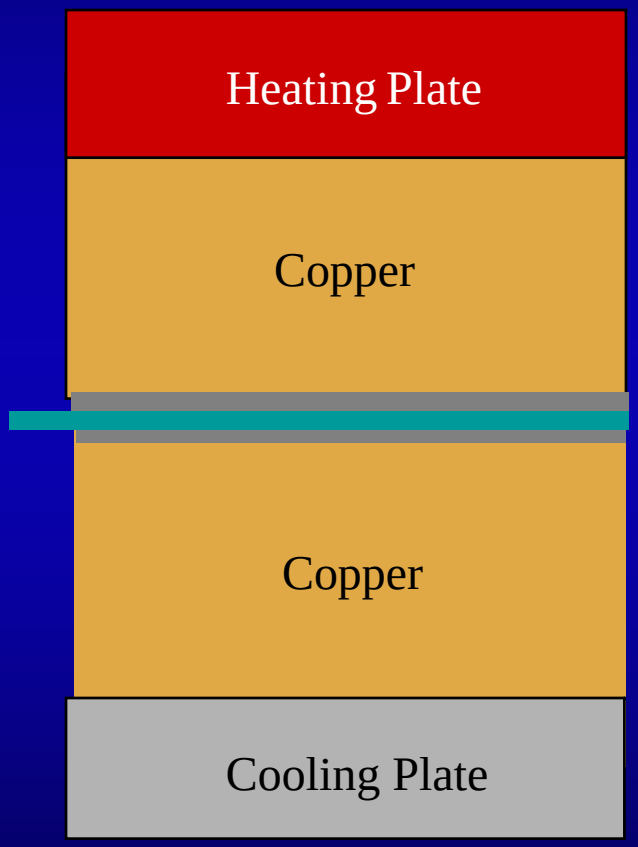
Quantifying Thermal Interface Resistance

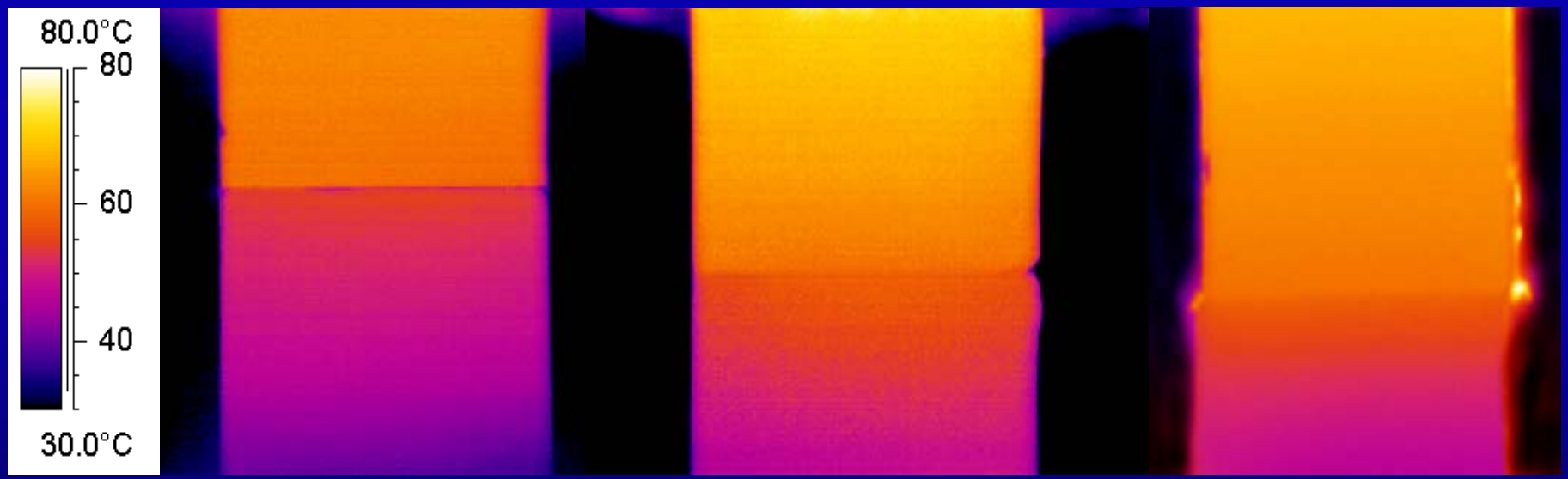
IR Imaging to quantify conductivity



IR Camera

A Comparison of Interface Materials

Conventional Thermal Paste	NanoBonded™ Joint	NanoBonded™ Joint
Cu-Cu	Cu-Cu	Cu-AlN



10x higher thermal conductivity

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TIM Competitive Products for Cu-Cu joints

TIM Product	Thermal Conductivity (W/mK)	Thermal Resistance (Kin^2/W)
Thermal Adhesive (Arctic Alumina)	2.6	.14
Thermal Pad (Akasa Shin Etsu)	0.7	.12
Thermal Grease (Shin Etsu G751)	0.9	.08
Nanobond™	77.0	.003

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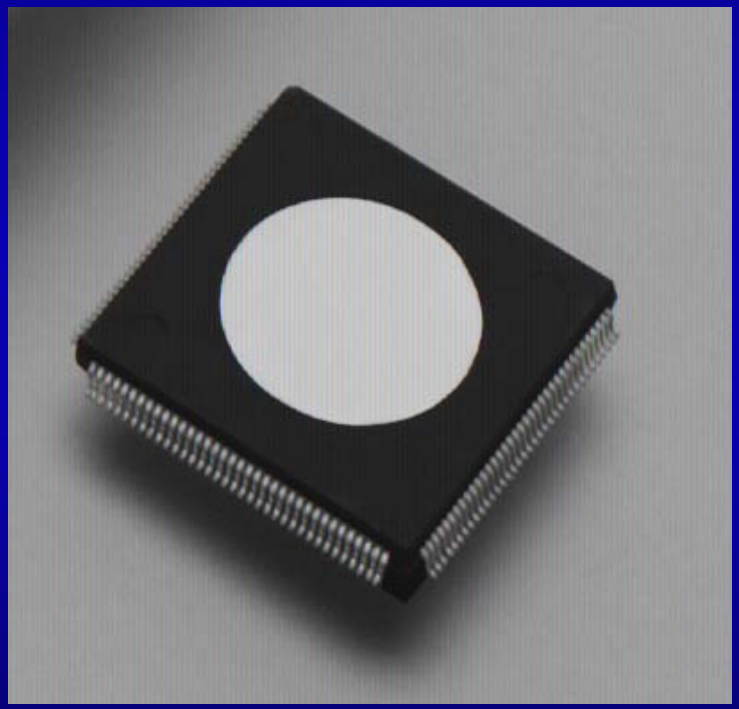
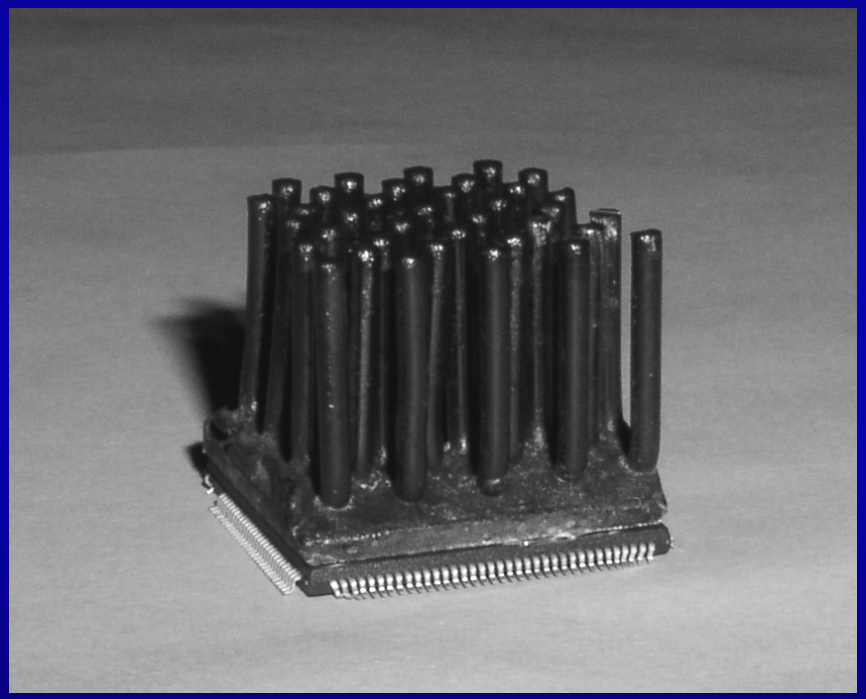
Teradyne Application
Cu Heat Spreader to
Cu Heat Sink





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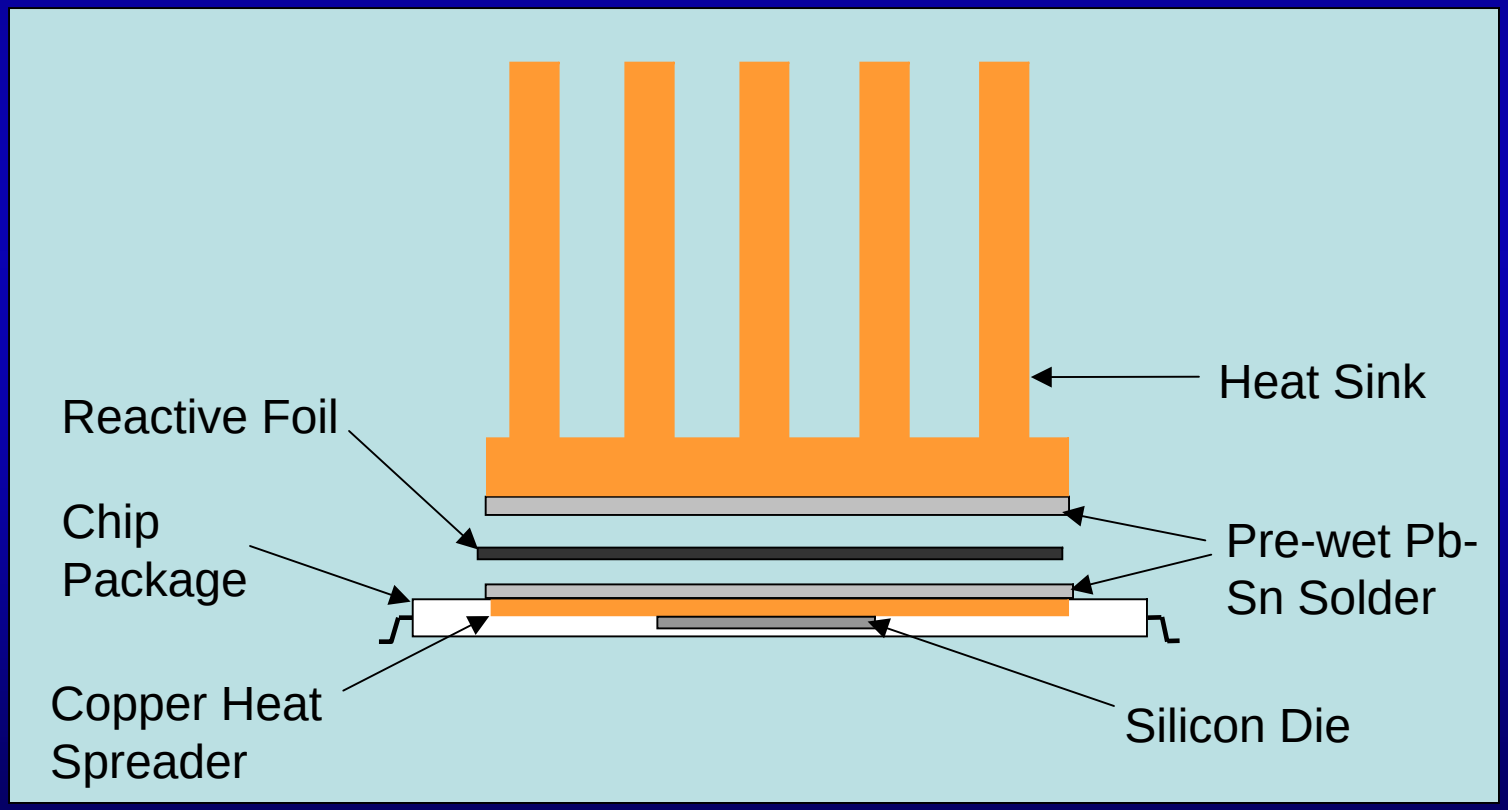
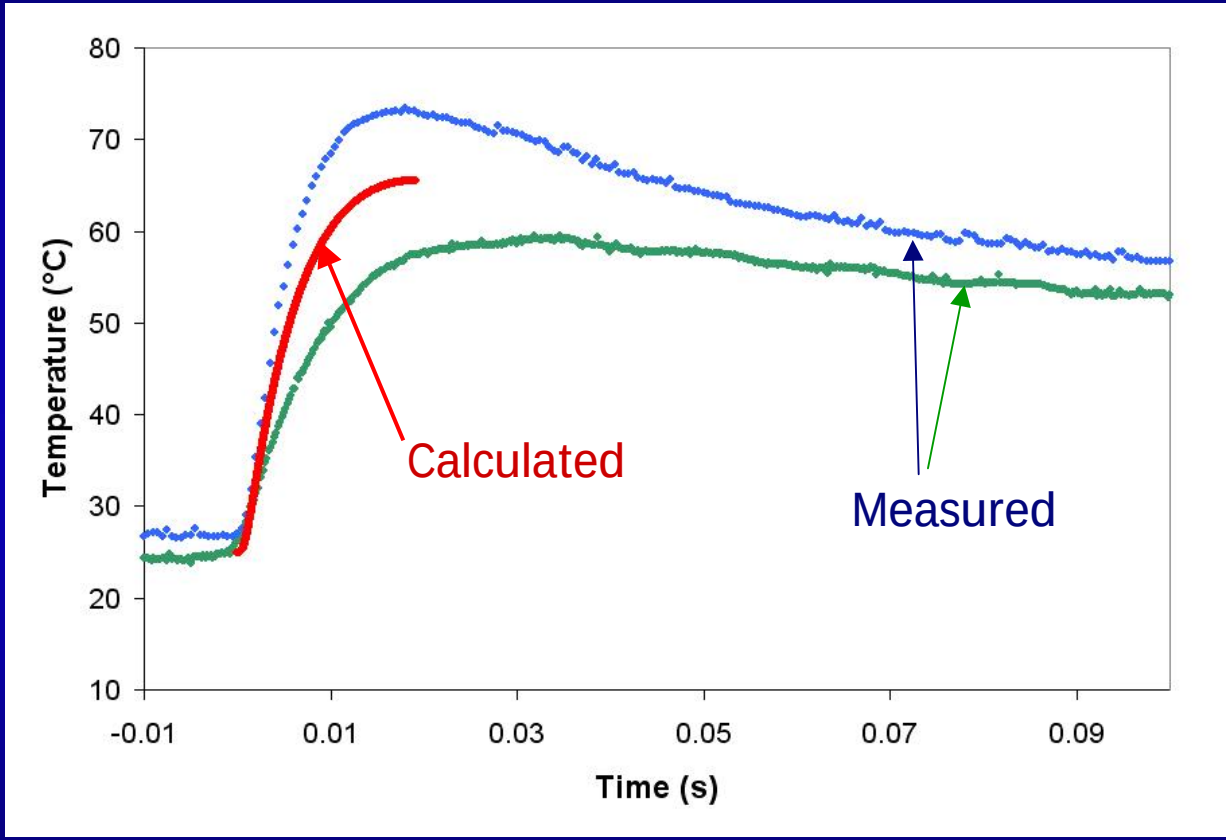
Teradyne Application

- Quantify air-cooling extension with a metal bond for TIM2.
- NanoBond™ Cu heat sink onto Ni-plated Cu Chip Package.



Junction Temperature Response during NanoBonding™



The low predicted and measured temperatures show that the chips will not be damaged during joining

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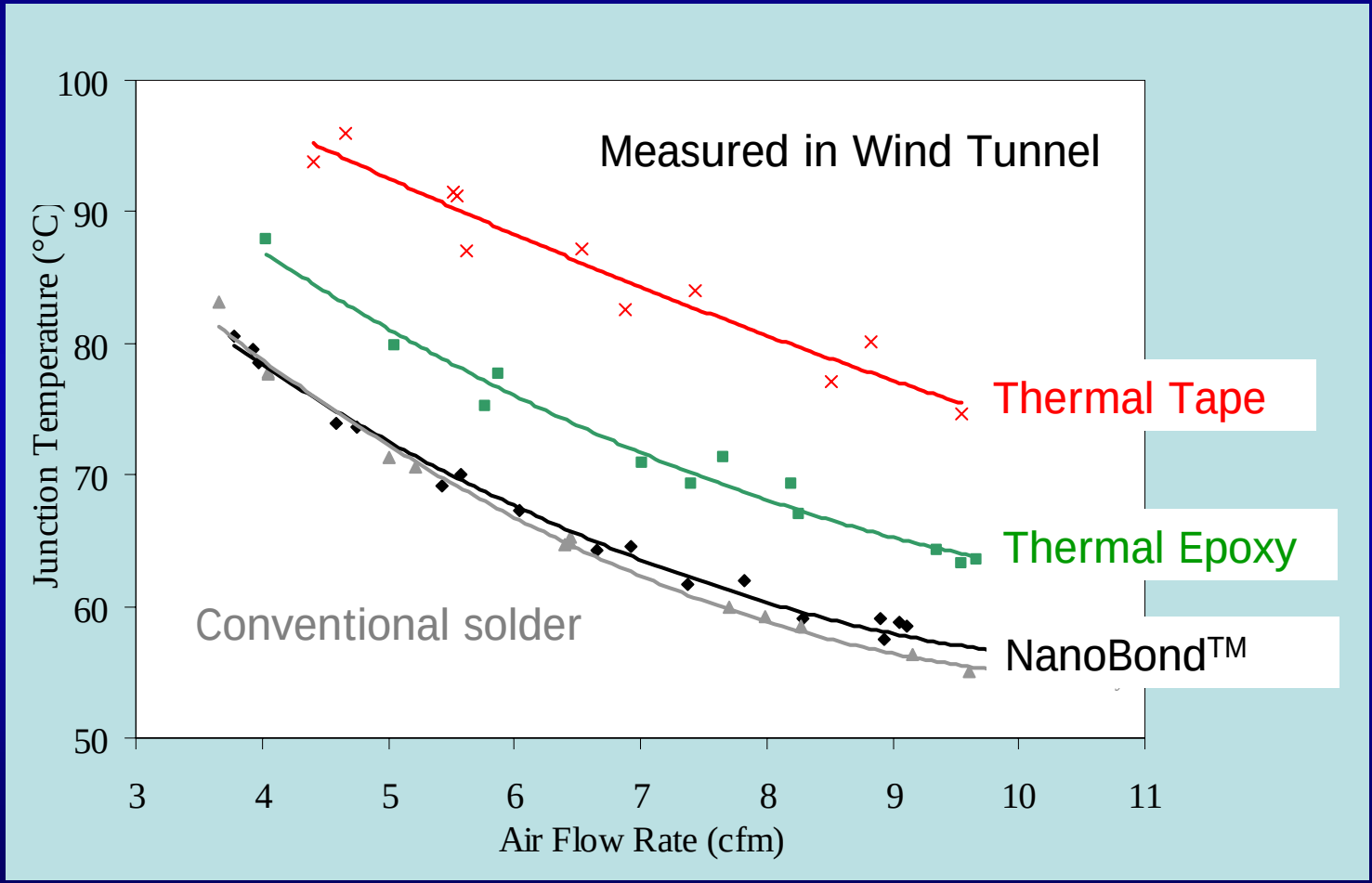
Temperatures during Operation

Junction temperature for taped, epoxied, conventionally soldered and NanoBonded™ mounts measured under identical loading conditions.



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