PowerSite™ Technologies

- Next-generation thermal management
- Based on all-polyimide TPI bond film
- Proprietary (*patented, patents pending*)

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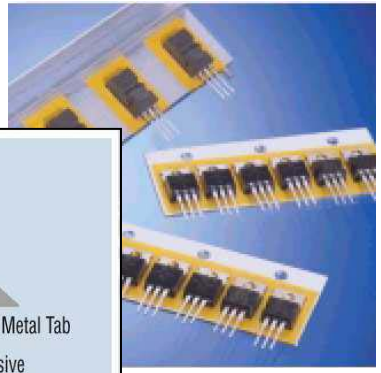
Next-Generation Thermal Management

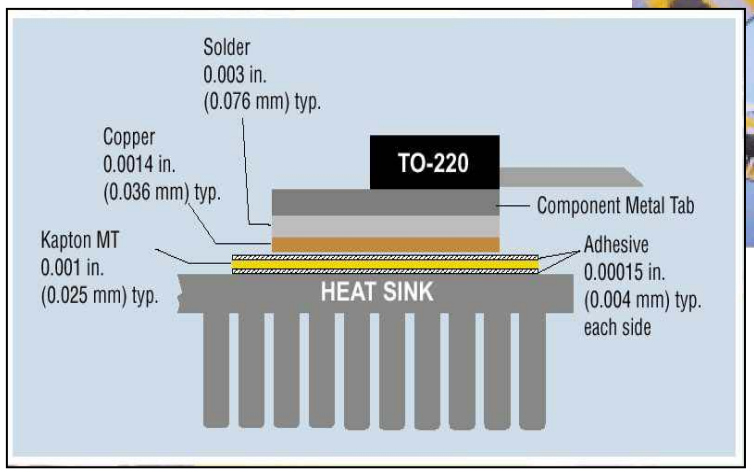
HEAT-SEALED METAL SURFACES

- Allow soldering of power devices to heat sinks
- RESULT: Excellent thermal transfer with no attachment hardware
- Kapton* electrical insulation
- All-polyimide adhesive durability

POWER TECHNOLOGY CHANGES SLOWLY

- Greatest need for thermal management
- Adoption cycles are long…. but position secure once adopted:





THERMAL INTERFACE	Introduction
Mica/grease	1940s
Sil-Pads	1960s
Ceramic (DBC)	1960s
Insulated metal substrate (IMS)	1980s
PowerSites	***2000***

Brief history of polyimides

DIELECTRIC FILM:

- Chemistry invented in early ’60s (DuPont)
- Kapton ‘H’ film patented in 1964
- Filmed films introduced in mid ’80s (DuPont MT)

FRAIVILLIG TECHNOLOGIES:

- TPI bond film (1995) – *basis for application-specific products*:
- PowerSite patches (1999)
- PowerFlex circuits (2001)
- PowerVia columns (2001)
- CuprImide substrates (*under dev.*)

ADHESIVE (thermoplastic):

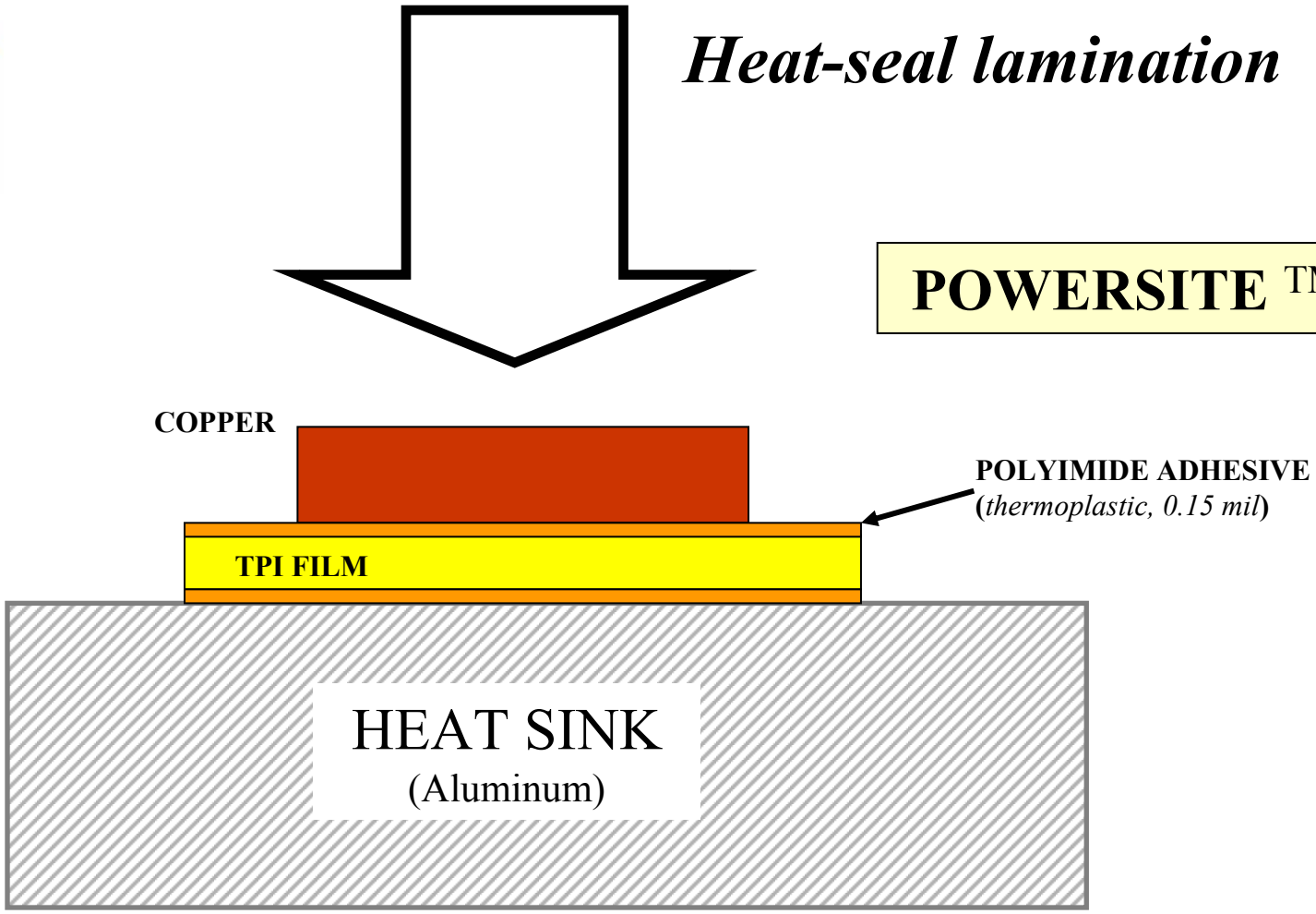
- Developed in late ’70s by NASA
- System developed for “atom smashers” in late ’80s
- All-polyimide systems developed for flexible laminates in early ’90s

PI ADHESIVE FEATURES:

- *Comparable properties to PI films => adhesive no longer the “weak link”*
- *Strong bond even when thin (0.1-0.2 mil) – maximize thermal transfer, while minimizing cost*
- *Heat-sealable – fast, single-unit production*

Heat-seal lamination

POWERSITE TM



Performance advantages of PowerSites:

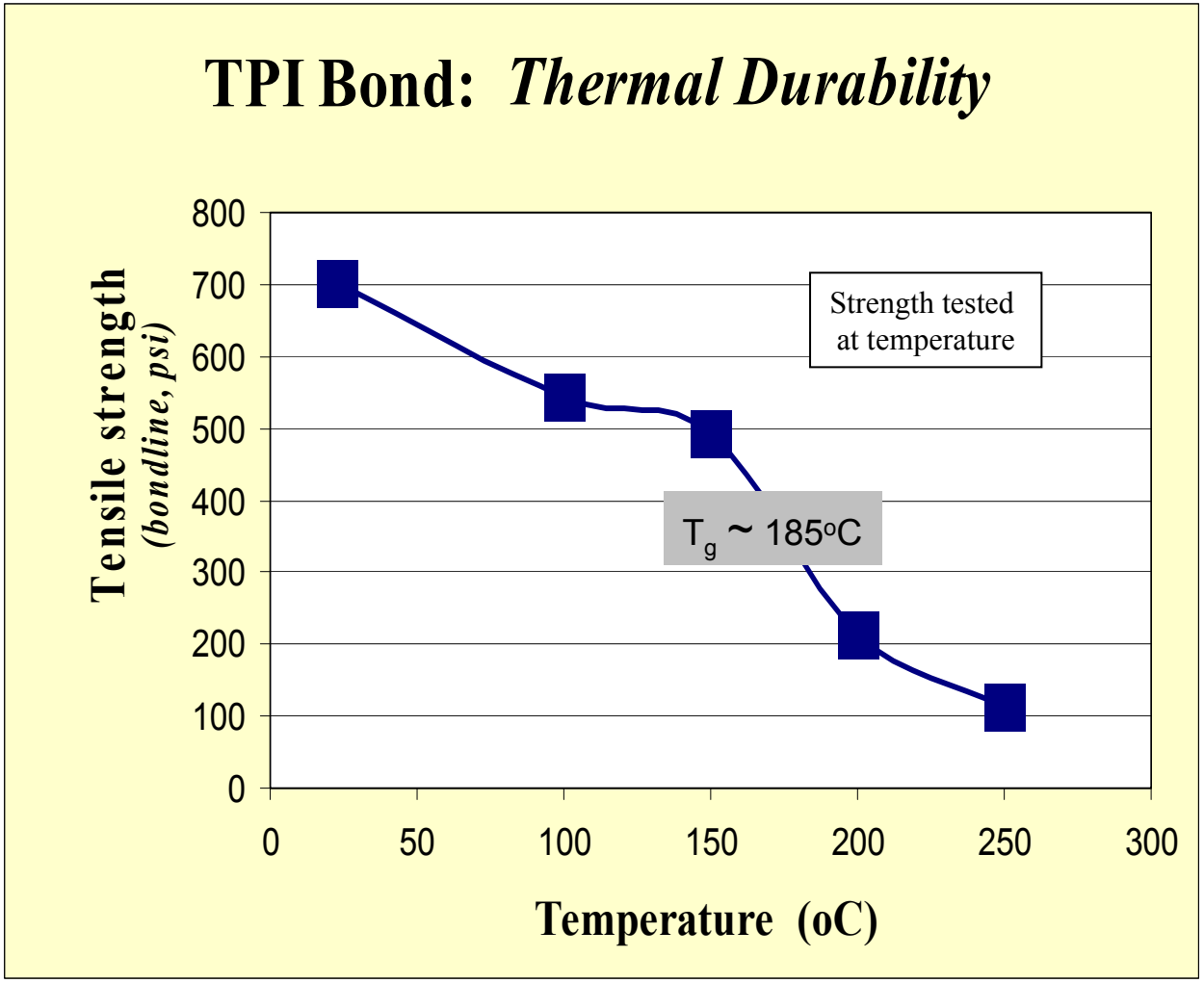
- *Thin, highly thermally-conductive insulation*
- *All-polyimide durability*
- *Any heat sink*
- *No device attachment hardware*

TPI bond durability

TENSILE STRENGTH
- High and consistent to 150°C+ *(see chart opposite)*
- No/little degradation with thermal aging to 150°C+

SHEAR STRENGTH
- Room temp = 4000 psi
- 150°C = 2000 psi

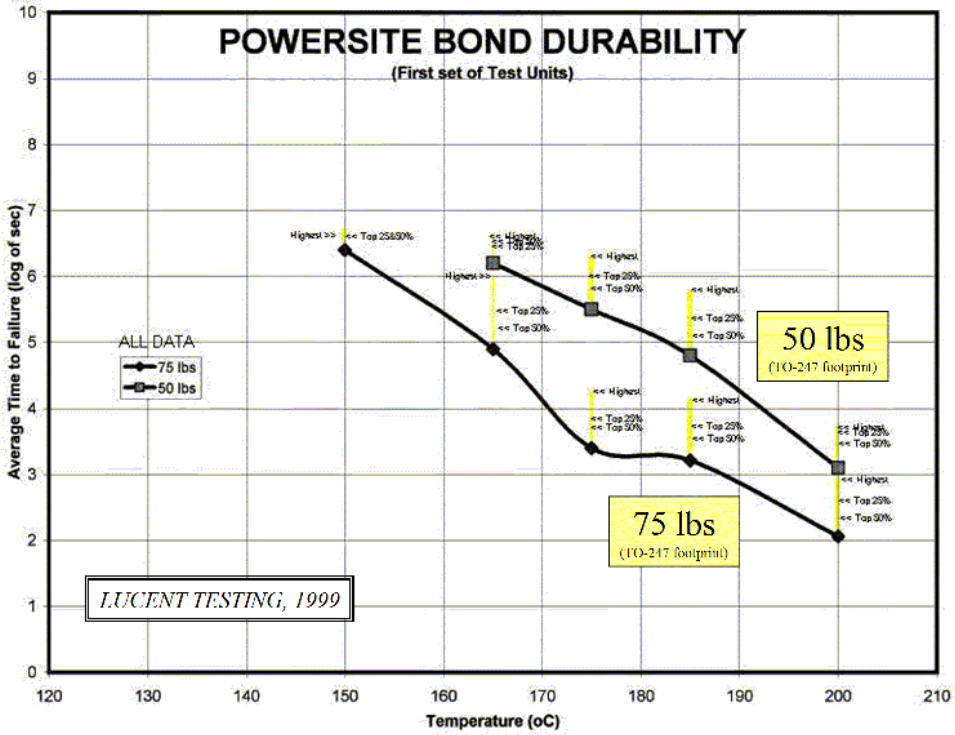
THERMAL TRANSFER
Unchanged with:
- Thermal shock
- Thermal cycling
- Thermal aging
- 85/85 aging

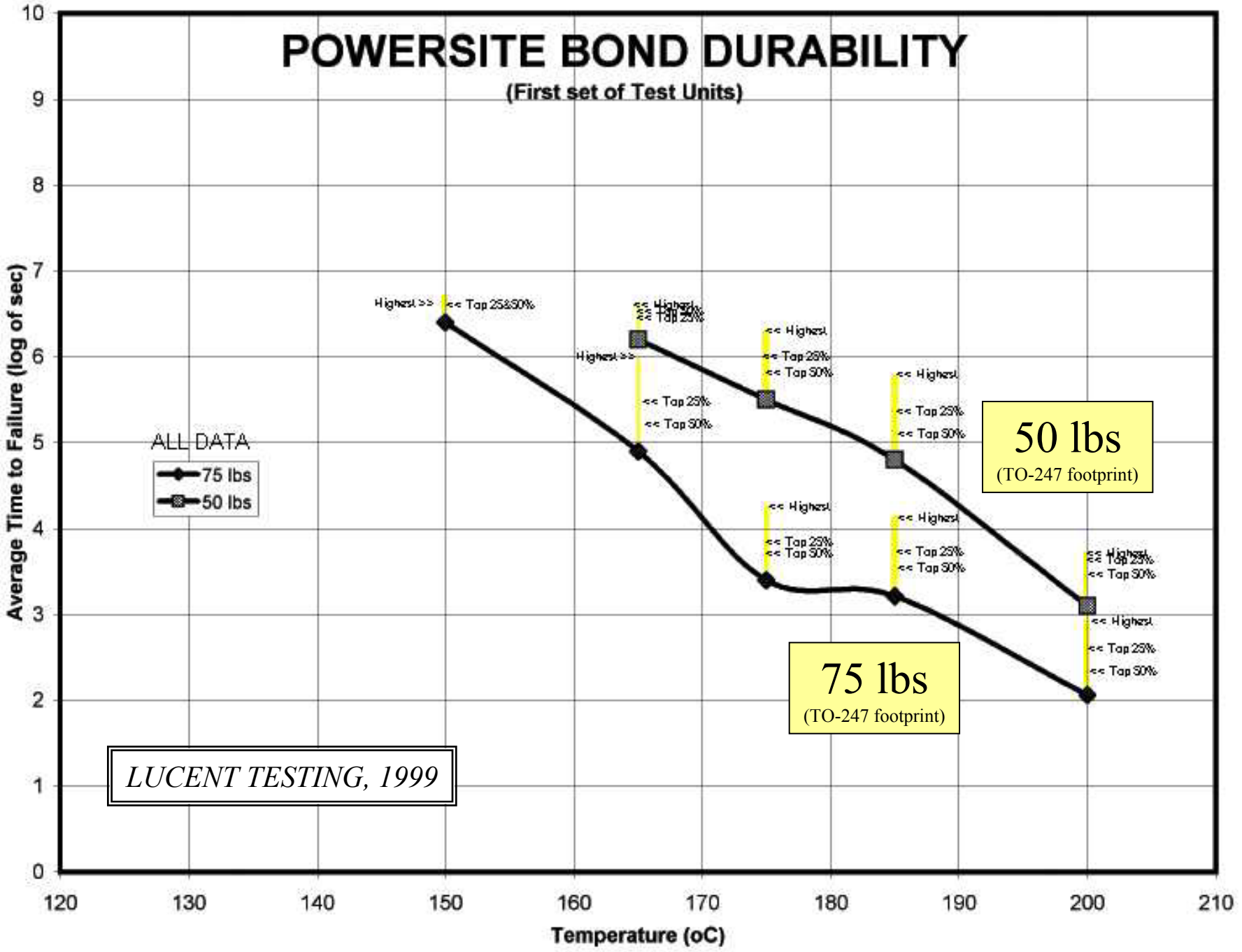


PowerSite 'hang-test' at Lucent--Mesquite

- Constant dead weight on TO-247-sized fixture (50 and 75 lbs)
- Constant high-temperature exposure (up to 200°C)
- Copper fixture bonded to aluminum baseplate (no solder joint)
- Measured time-to-failure in tensile mode
- Temperature-vs-time relationship appears inverse-logarithmic
- CONCLUSION:

Continuous exposure to temperatures less than 150°C will not degrade the strength of the PowerSite TPI bondline.




POWERSITE BOND DURABILITY
(First set of Test Units)
Average Time to Failure (log of sec)
Temperature (oC)
0
1
2
3
4
5
6
7
8
9
10
120
130
140
150
160
170
180
190
200
210
ALL DATA
75 lbs
50 lbs
50 lbs
(TO-247 footprint)
75 lbs
(TO-247 footprint)
LUCENT TESTING, 1999