

INSULATION FOR THERMAL MANAGEMENT IN MOBILE ELECTRONIC DEVICES

Lindsey Keen
Technical Leader
Thermal Management



Together, improving life



Outline



Thermal Challenge in Mobile Electronics



Insulation as a Thermal Solution



Device Demonstration

Mobile Electronics Megatrends

Shrinking Form Factors

- Thin, Flexible, Wearable



Devices are getting smaller



Increasing Power

- Continuous Advancements in Mobile Processors & Connectivity

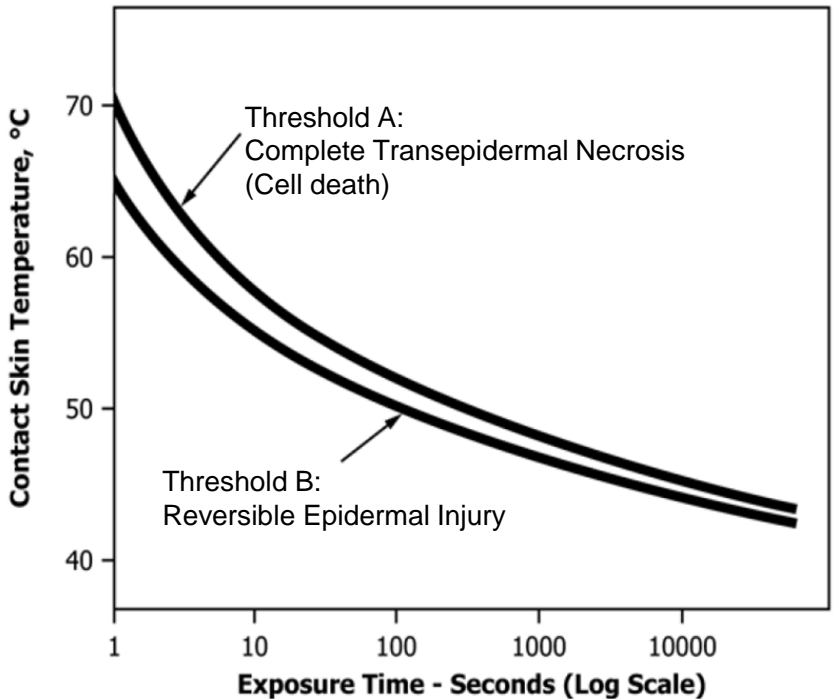


Processors are getting hotter

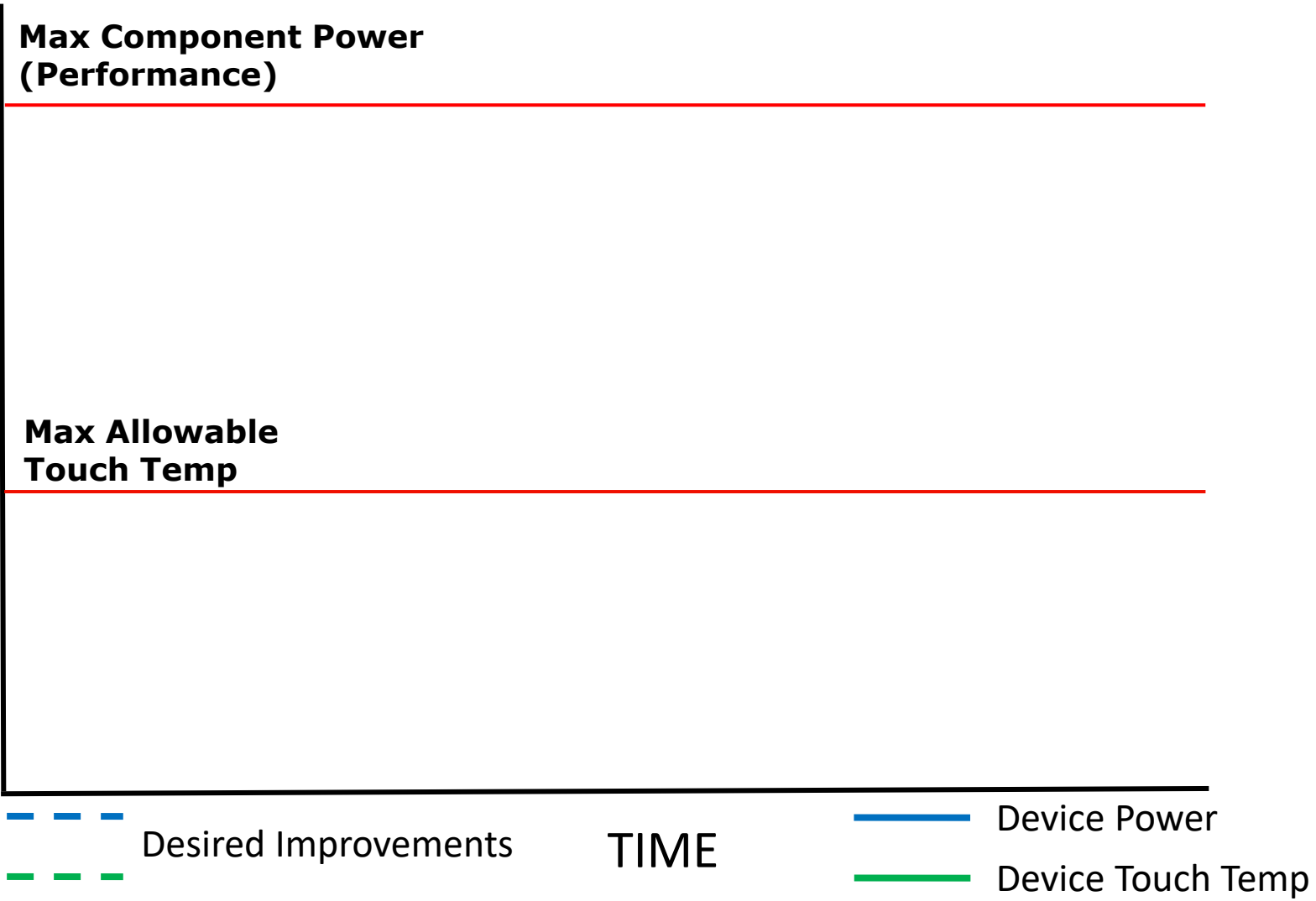


Engineering Challenge: Increasing Performance while Maintaining Safe Touch Temperatures

Time-Temperature Relationship for Skin Burns



Source:
ASTM Designation: C1055-03
"Standard Guide for Heated System Surface
Conditions that Produce Contact Burn Injuries"

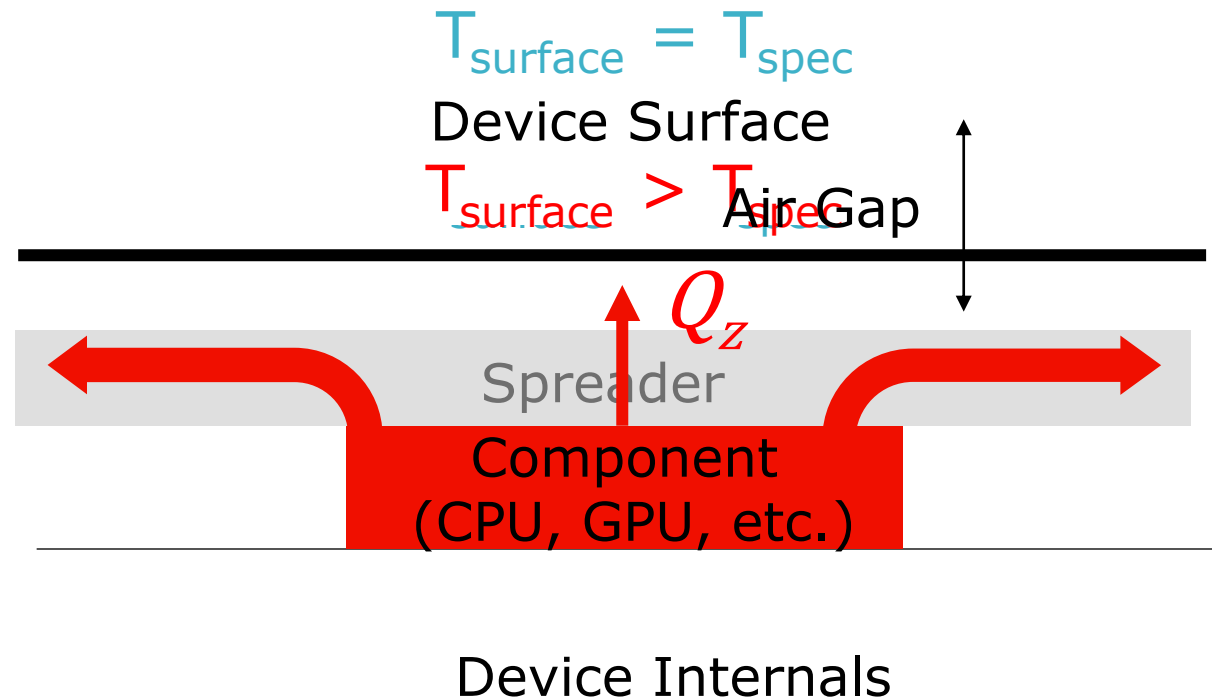
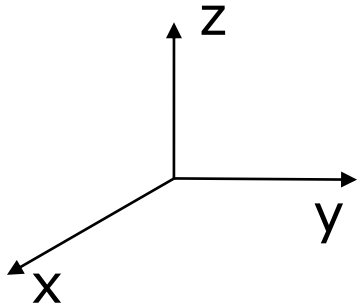


Heat Transfer in Mobile Devices

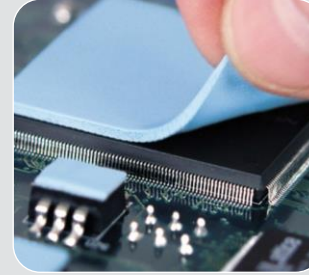
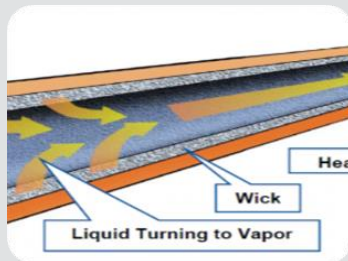
Fourier's Law: $Q = -\frac{kA\Delta T}{l}$

Where:

Q = heat flow, A = area, k = thermal conductivity,
T = temperature, l = length



Typical Passive Thermal Management Options



Spreaders

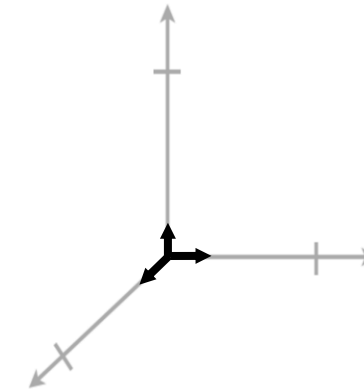
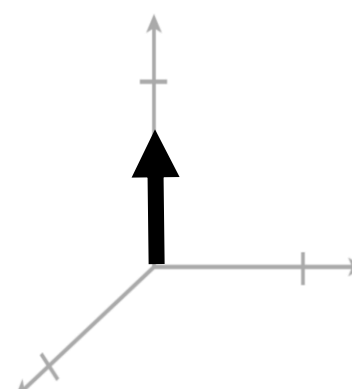
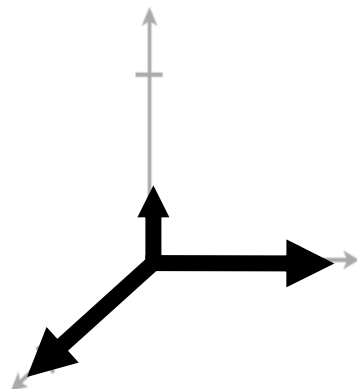
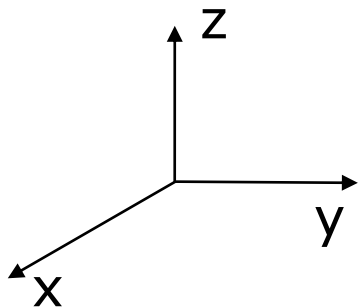
- Graphite
- Heat Pipes
- Vapor Chambers

TIMs

- Pads
- Pastes

Insulators

- Air
- Polymers
- Aerogel



Unique Combination of Materials

Silica Aerogel



Ultra-low thermal conductivity $<0.02 \text{ W/(m}\cdot\text{K)}$ ✓

Extremely brittle ✗

High particulation ✗

GORE® Thermal Insulation



✓ Ultra-low thermal conductivity: $<0.02 \text{ W/(m}\cdot\text{K)}$

✓ Thin form factor: 50-500 μm thickness

✓ Flexible, conformable, compressible

✓ Low particulation

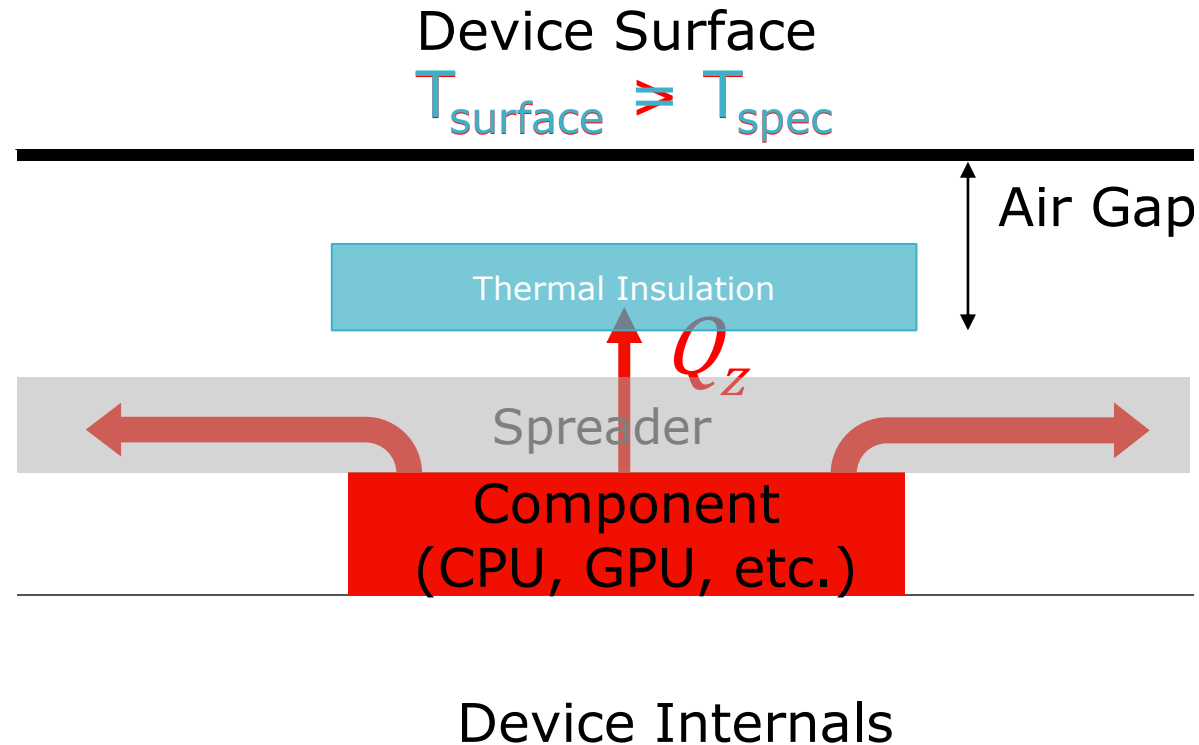
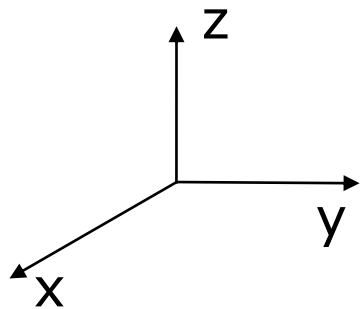
✓ Easily laminated and die cut

Heat Transfer in Mobile Devices

Fourier's Law: $Q = -\frac{kA\Delta T}{l}$

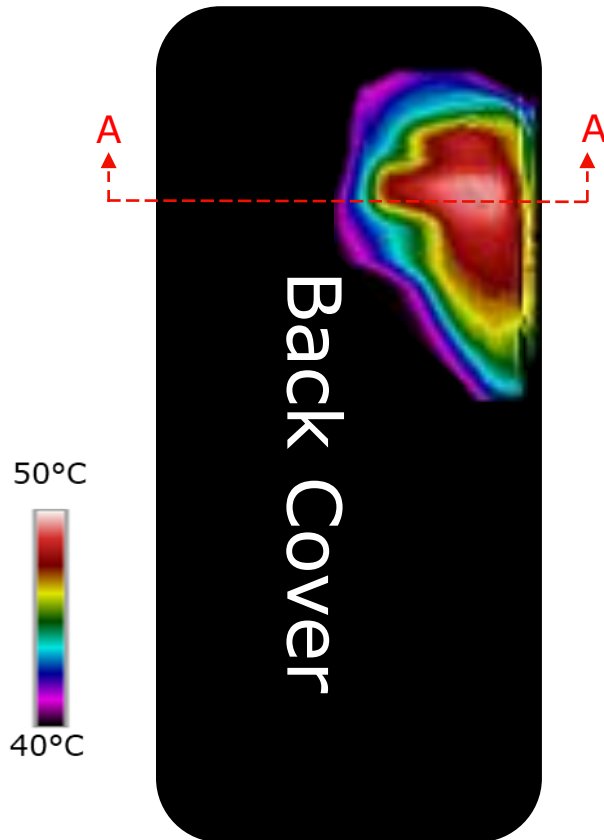
Where:

Q = heat flow, A = area, k = thermal conductivity,
 T = temperature, l = length

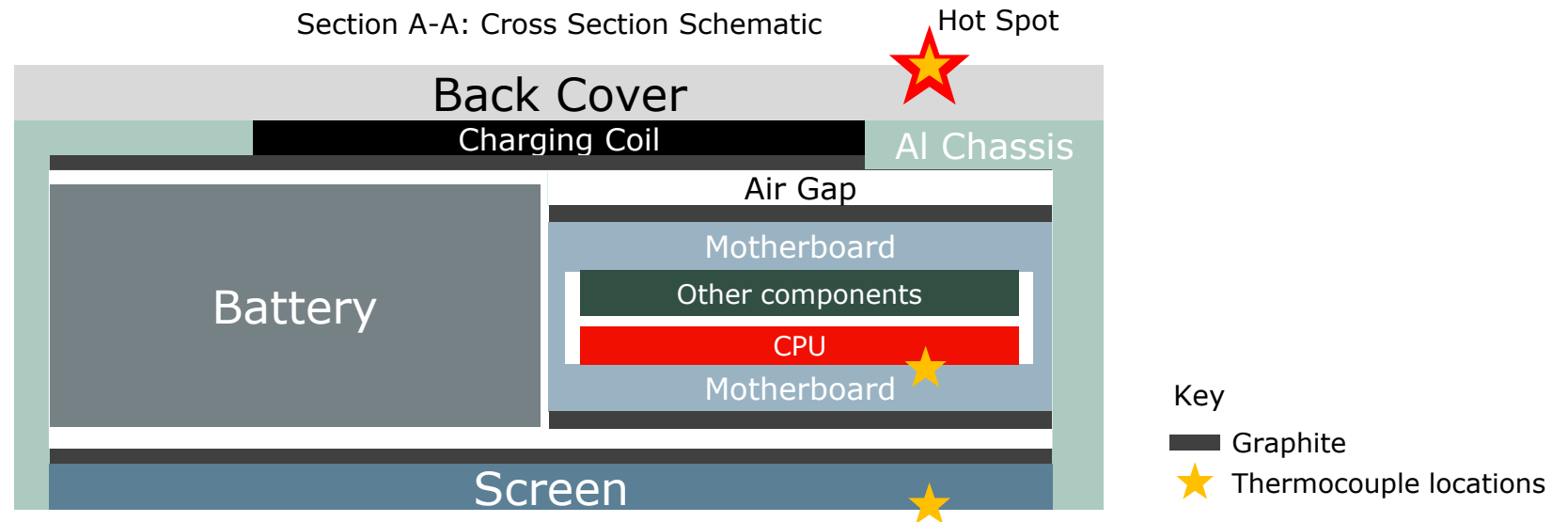


Device Demonstration

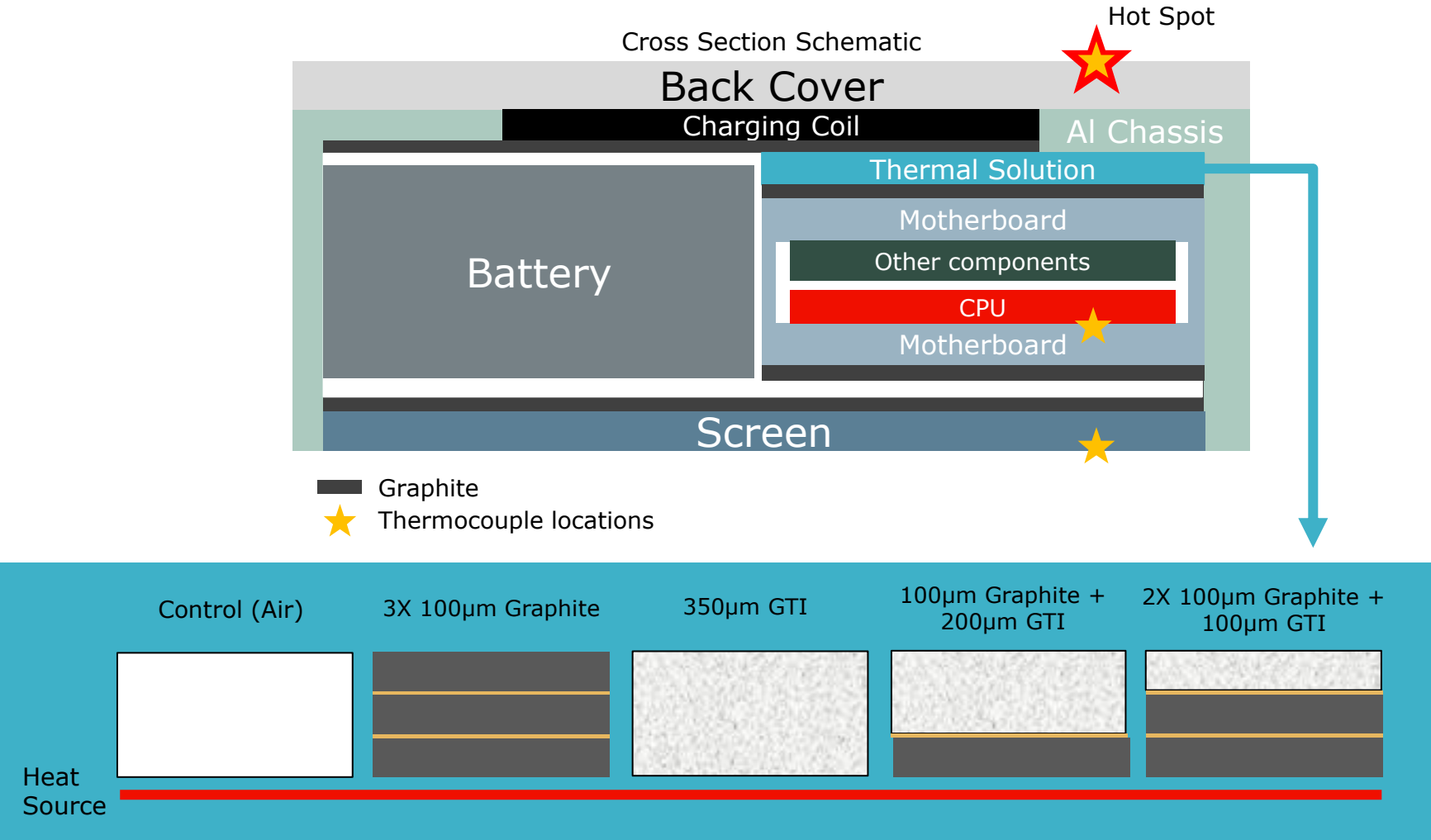
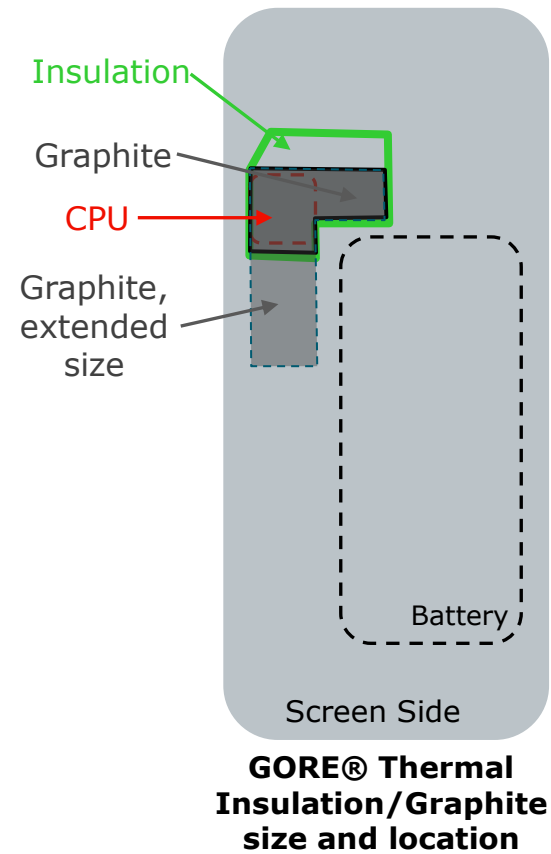
Smartphone



- Smartphone purchased and benchmarked with 3DMark software
- Hotspot size and locations monitored with IR imaging
- Surface & internal temperatures monitored with thermocouples



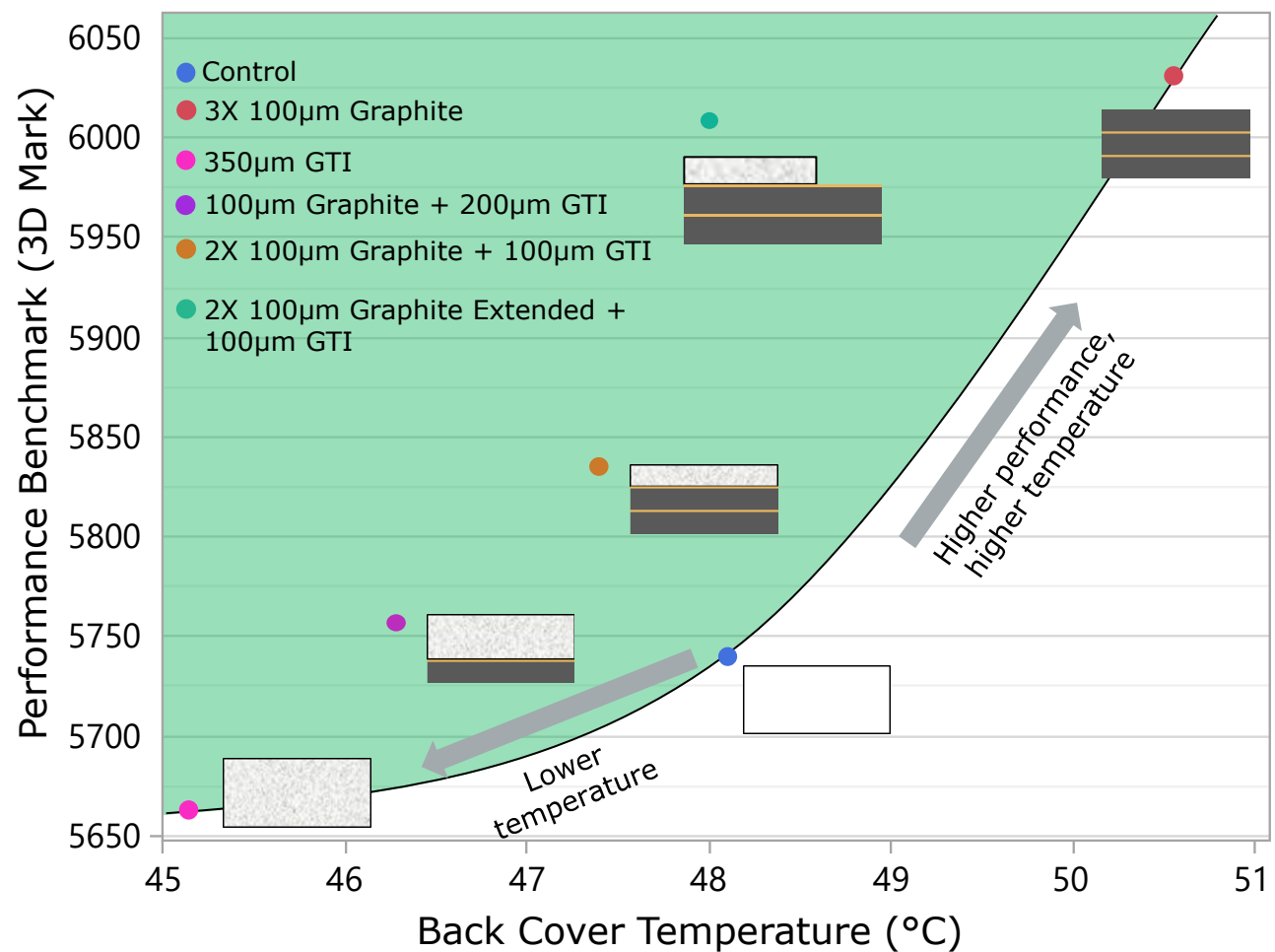
Testing Configurations



Thermal Solutions tested in device - Cross Section Schematics

Note: This Device was purchased commercially by Gore and retrofitted

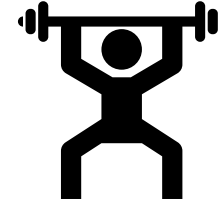
Performance Improvement with Graphite-Insulation Composite



- Control represents the out of the box solution
- All solutions are combined with the existing graphite on the motherboard and back cover

Configuration	Back Cover Surface Temperature: Delta to Control (°C)	Performance: % Change to Control
Control		

Summary



**Ultra-low thermal conductivity GORE® Thermal Insulation
can enhance device performance when paired with
spreading technologies**

THANK YOU

Together, improving life

