



# Kelvin Thermal's TGP Products

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RYAN J. LEWIS, DYLAN P. MCNALLY, RAY WU, GREG CHENG, & Y. C. LEE, KELVIN THERMAL

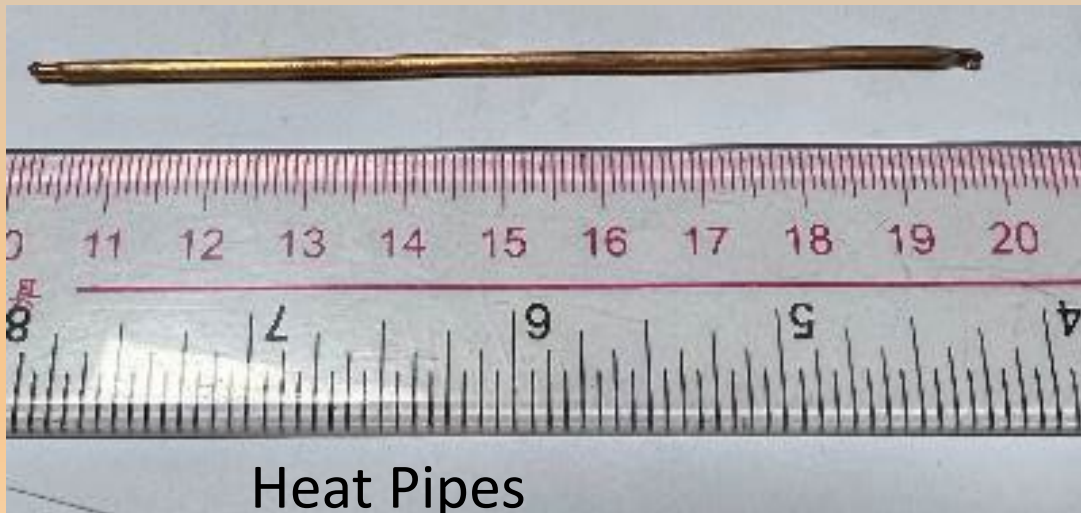
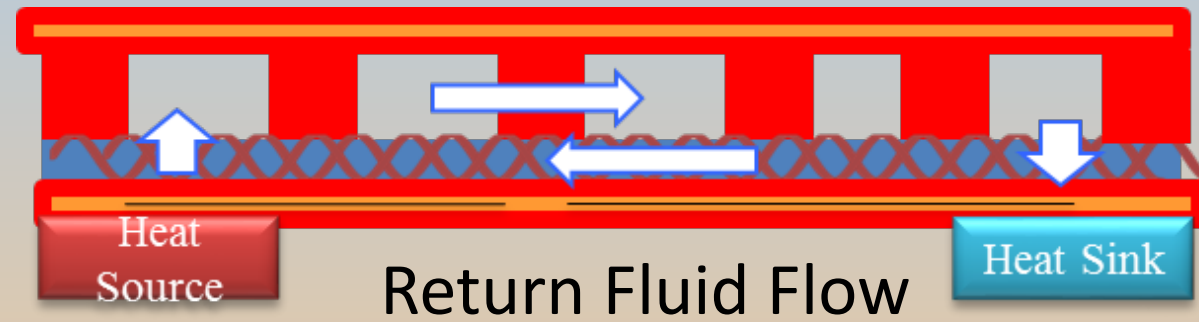
1500 KANSAS AVE, UNIT 4A, LONGMONT, CO 90501

CONTACT: Y. C. LEE AT [LEEYC@KELVINTHERMAL.COM](mailto:LEEYC@KELVINTHERMAL.COM)

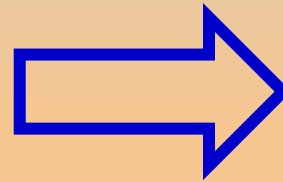


# Kelvin Thermal's TGPs (Vapor Chambers), i. e. 2D Heat Pipes

Evaporation → Vapor Transport → Condensation



Heat Pipes



# Why Vapor Chambers? Unique and Useful Heat Spreaders

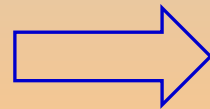


Microsoft Surface Book, Nov. 2015.



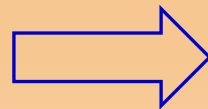
Samsung Galaxy Note 10+ 5G, August 2019.

**Using copper (400 W/mK) or  
graphite (1,200 W/mK) today?**



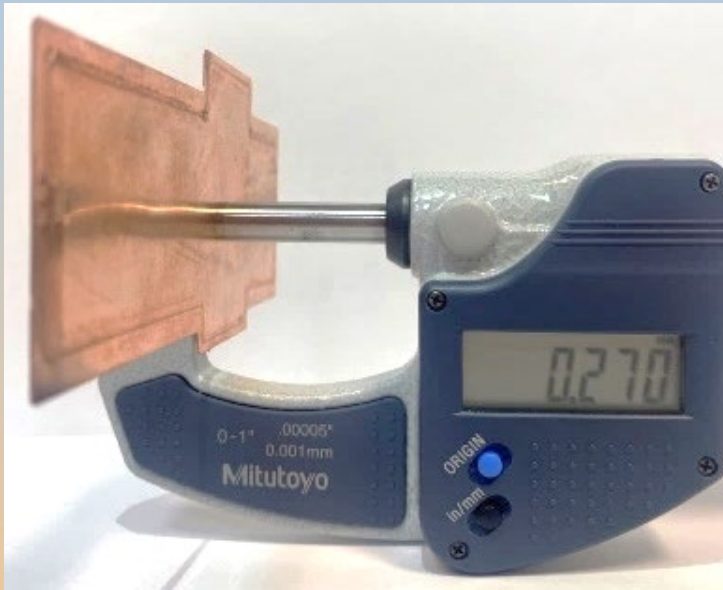
**Use vapor chambers with 5,000 to 30,000 W/mK!**

**Using vapor chambers or  
heat pipes today?**

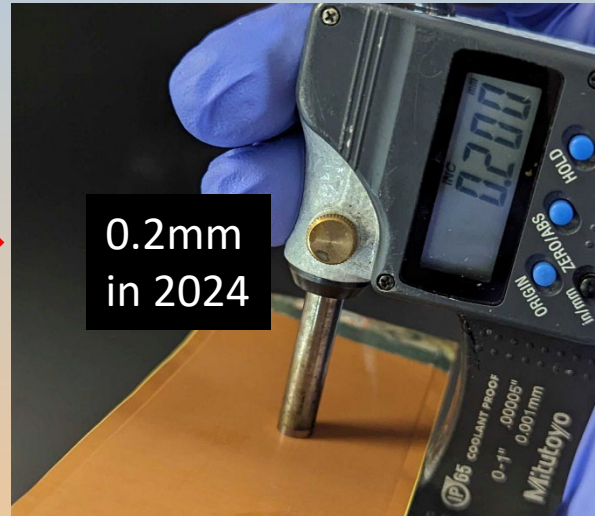
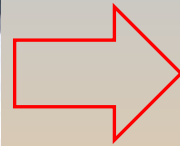


**Use Kelvin Thermal's cost competitive TGPs,  
which can be thin, light, flexible, foldable, large  
size, high heat flux, or high power.**

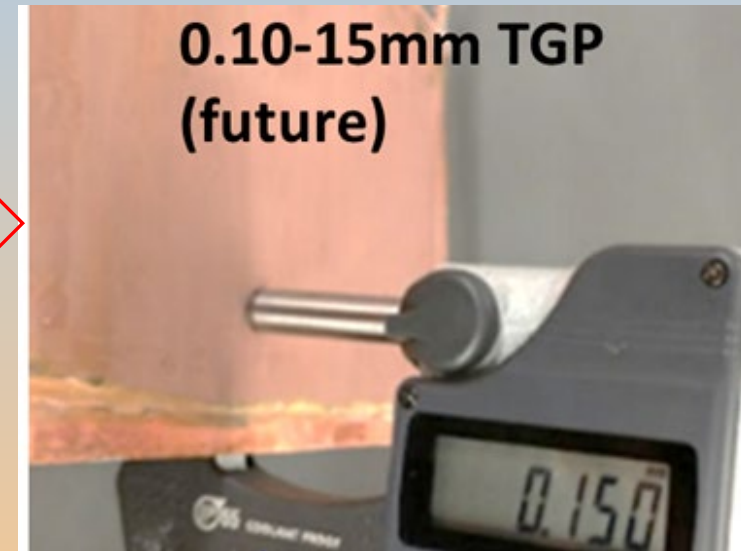
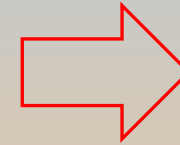
# TGP Product #1 – Very Thin & Light



State-of-the-art  
0.27mm vapor chambers



Kelvin Thermal's 0.2mm TGPs;  
engineering samples toward  
mass production soon.



Kelvin Thermal's 0.1-  
0.15mm TGPs to be  
produced by 2025-26.



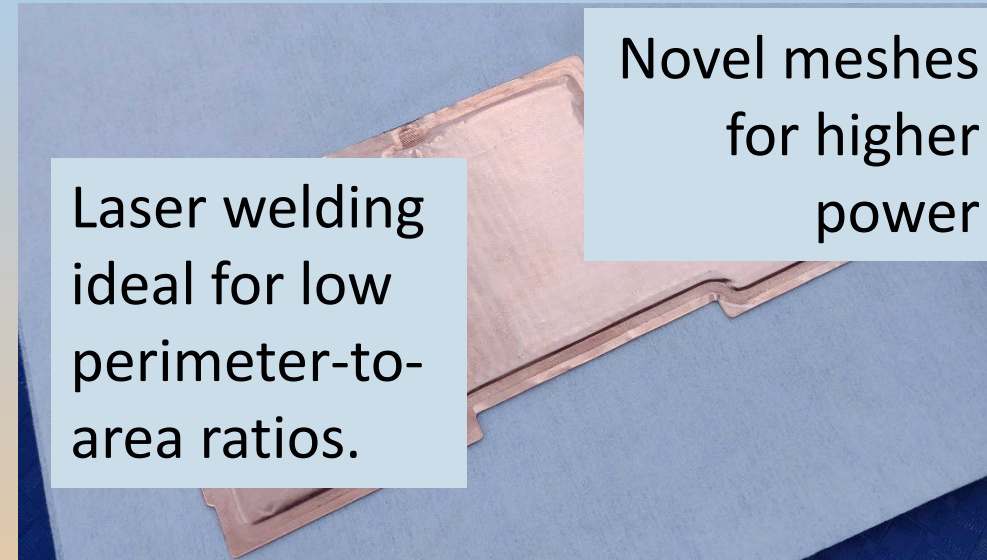
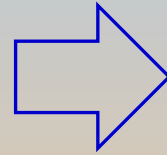
# Thinnest and Lightest Vapor Chamber



# TGP Product #2 – Large, Lighter and Lower Costs



Huawei MateBook X Pro  
2022; CPU/28 Watts; 0.8mm  
thick vapor chamber.



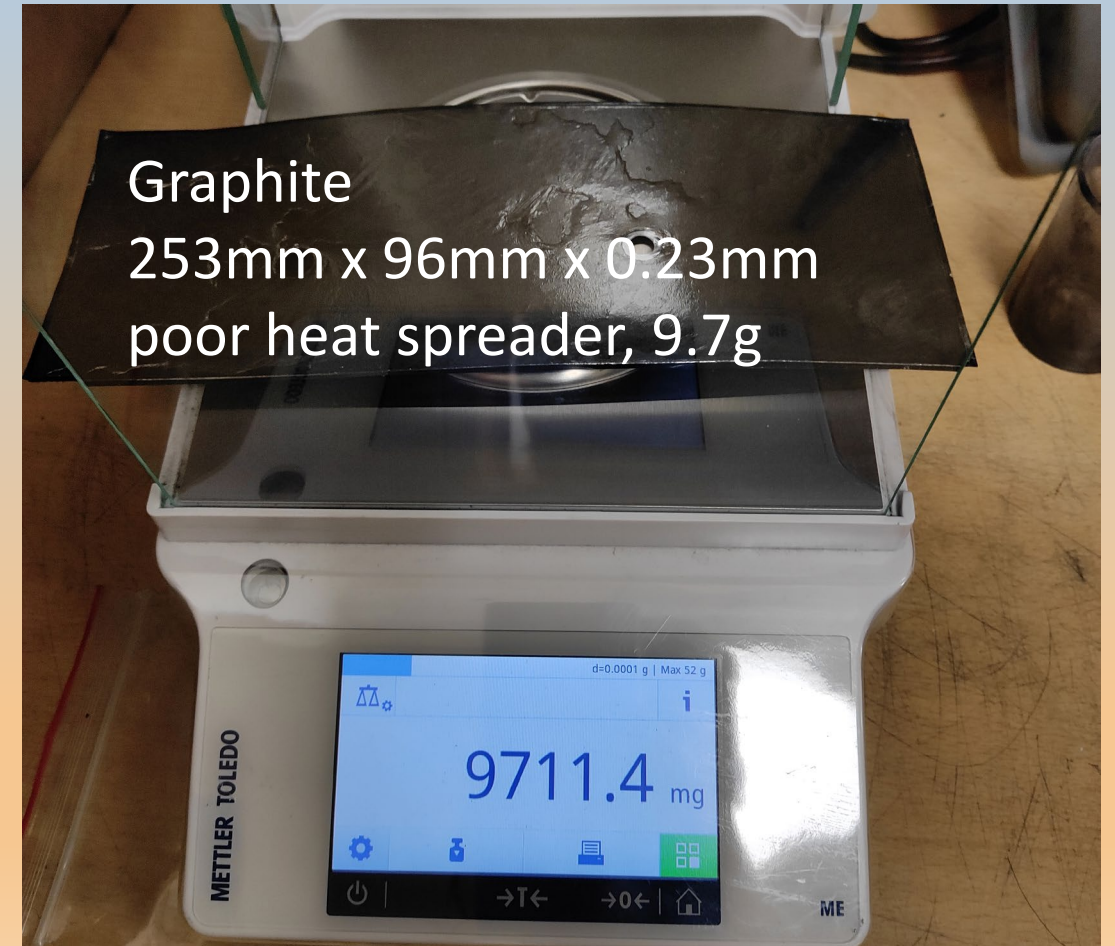
- Kelvin Thermal TGP; 60 Watts; 0.7mm thick
- Novel designs for cost reduction by 30-40%.
  - Other appealing features: thin & light (next slide), flexible, foldable, or high power.



# Graphite-light TGP's with Excellent $Q_{\max}$ and $K_{\text{effective}}$

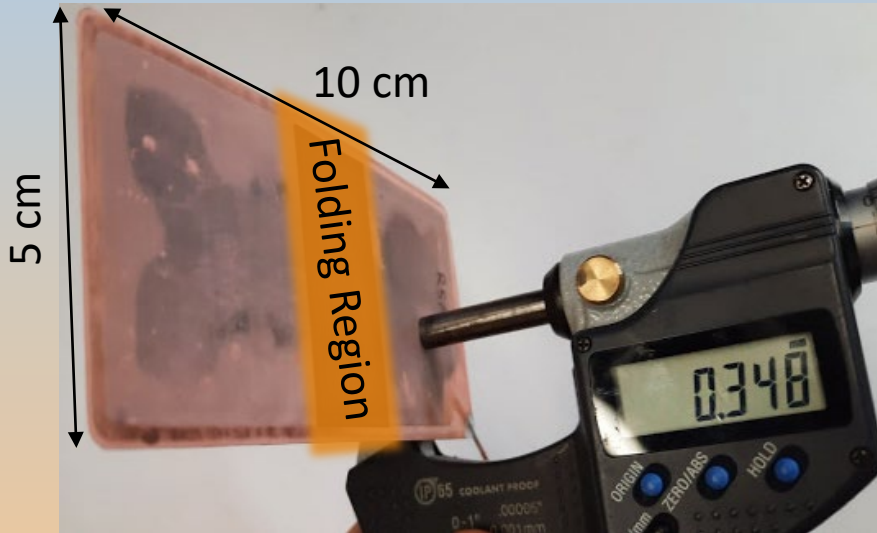


TGP's thermal conductivities: 6-20X higher than graphite's.

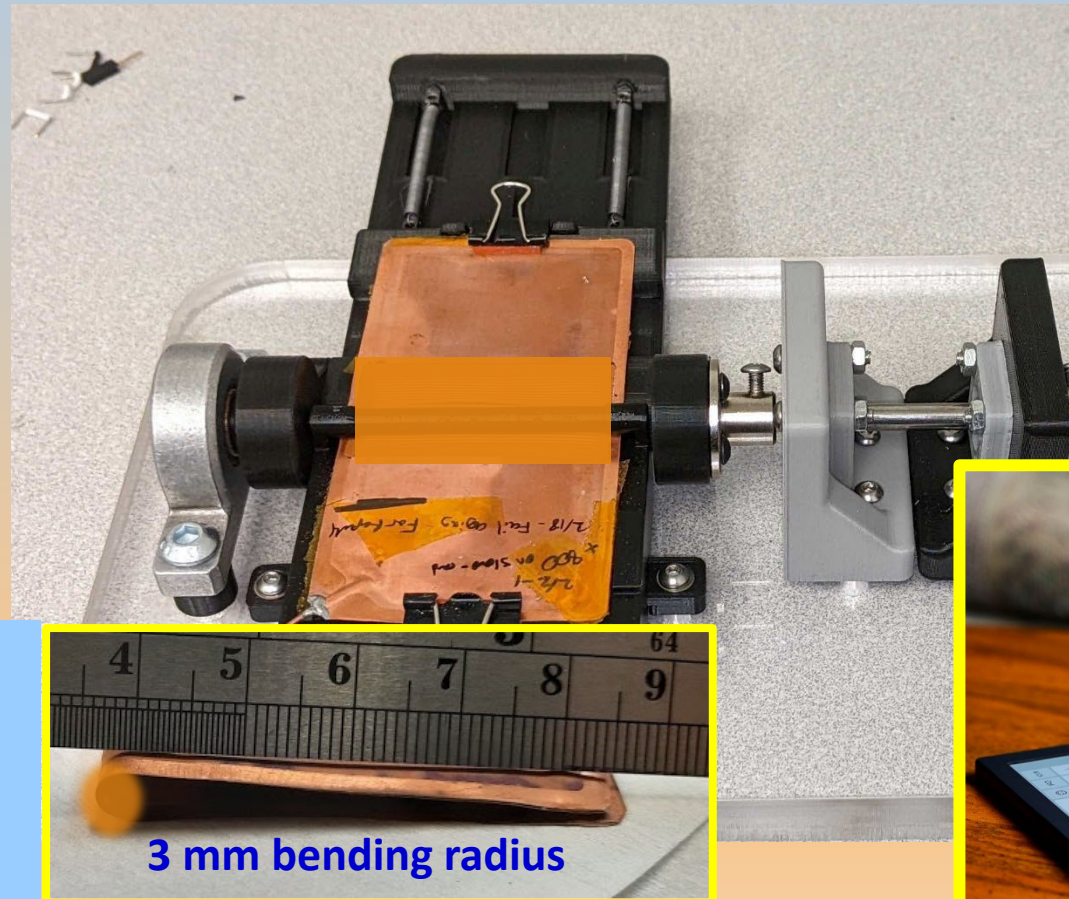
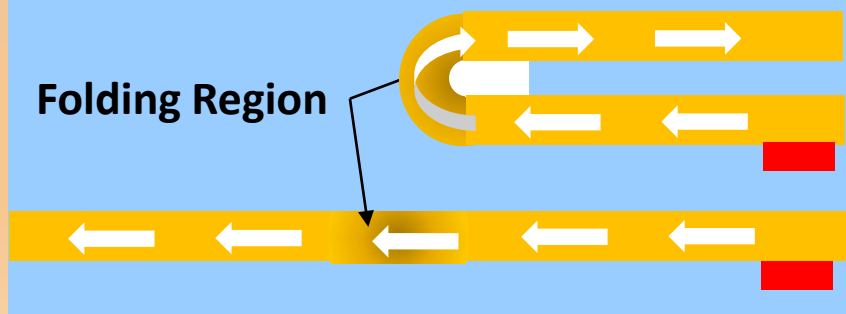


# TGP Product #3 – Foldable Vapor Chamber (World's Only One)

>200,000 folding cycles with a 3mm bending radius;  $\Delta T_{\text{Foldable TGP}} < 1/3 \Delta T_{\text{Foldable Graphite}}$

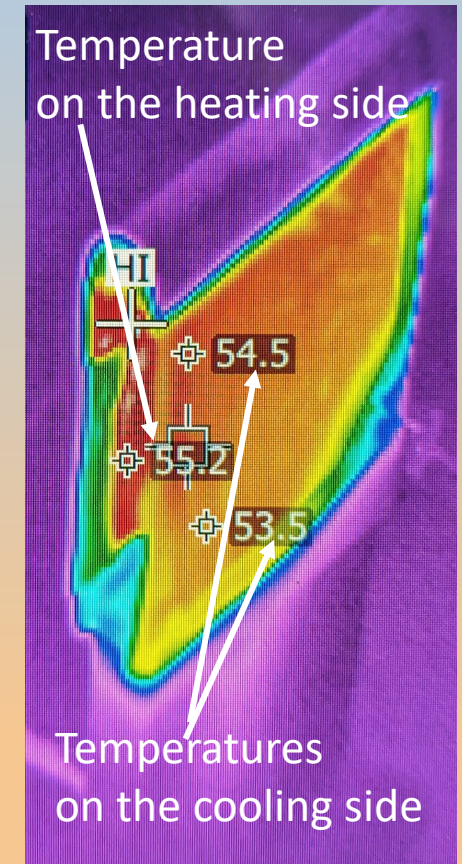


Continuous vapor and fluid transport





# Static Fold TGP (Simpler than Foldable TGP; Good for 3D Cooling)





# TGP Product #4 – Super Light

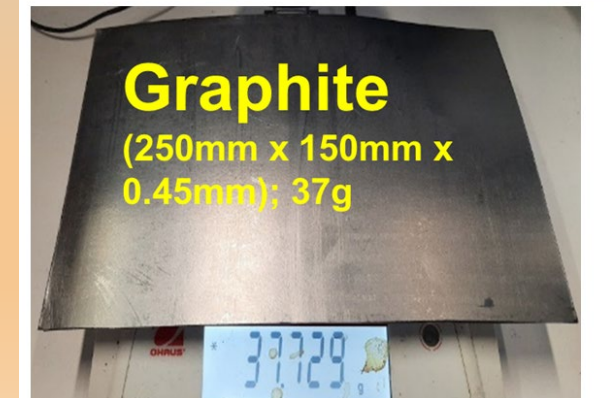
Existing Vapor Chambers



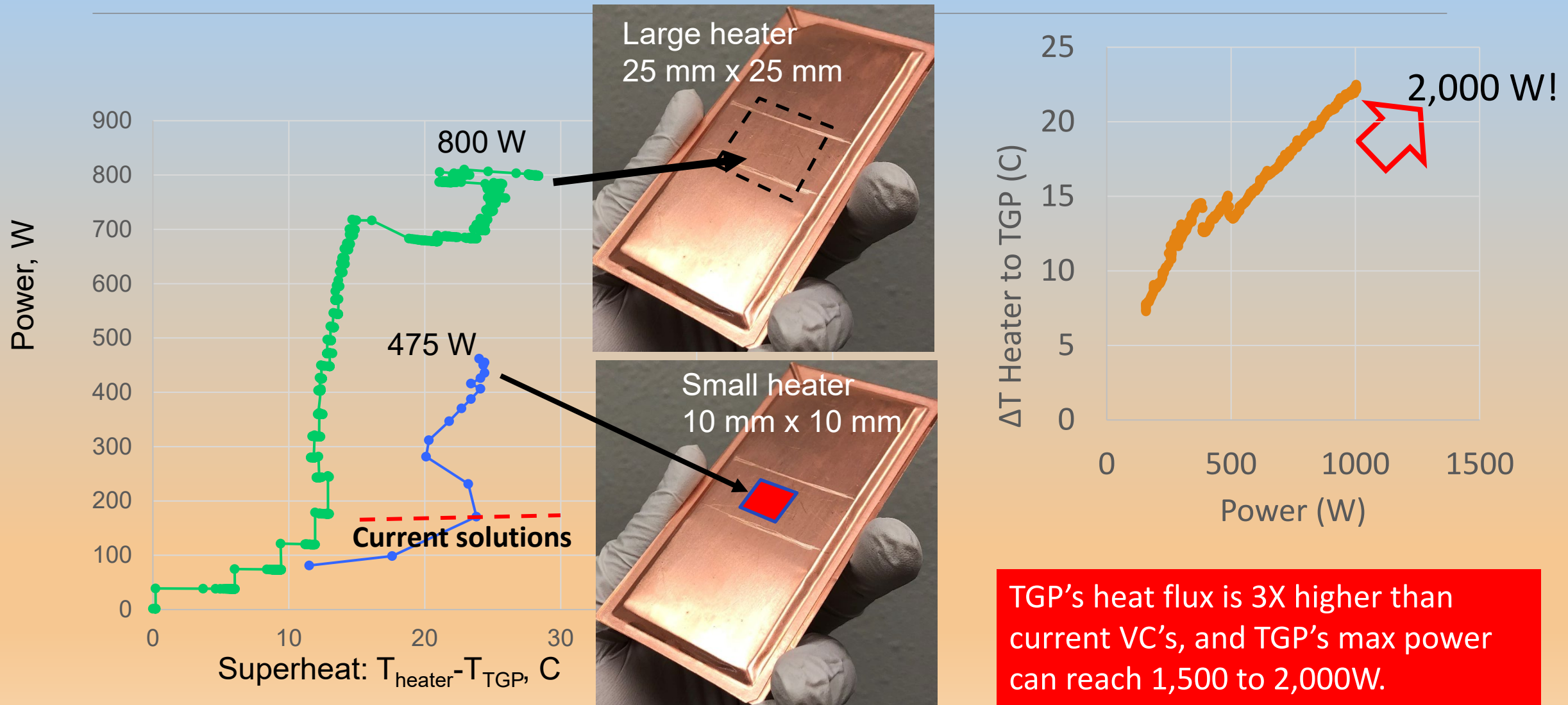
Kelvin Thermal's TGP



Reduce it to 10g with  
Graphite-Light TGPs  
(Note: TGP below is larger.)

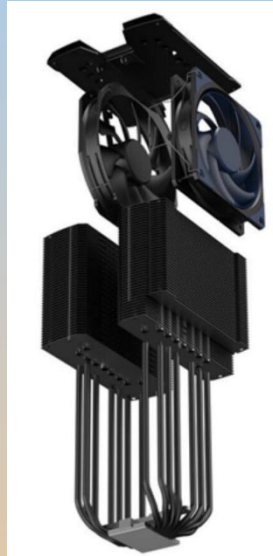


# TGP Product #5 – High Heat Flux & Power



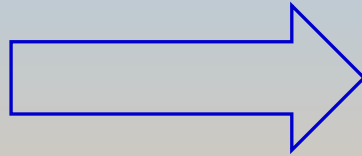


# Kelvin Thermal's Custom-Designed TGP



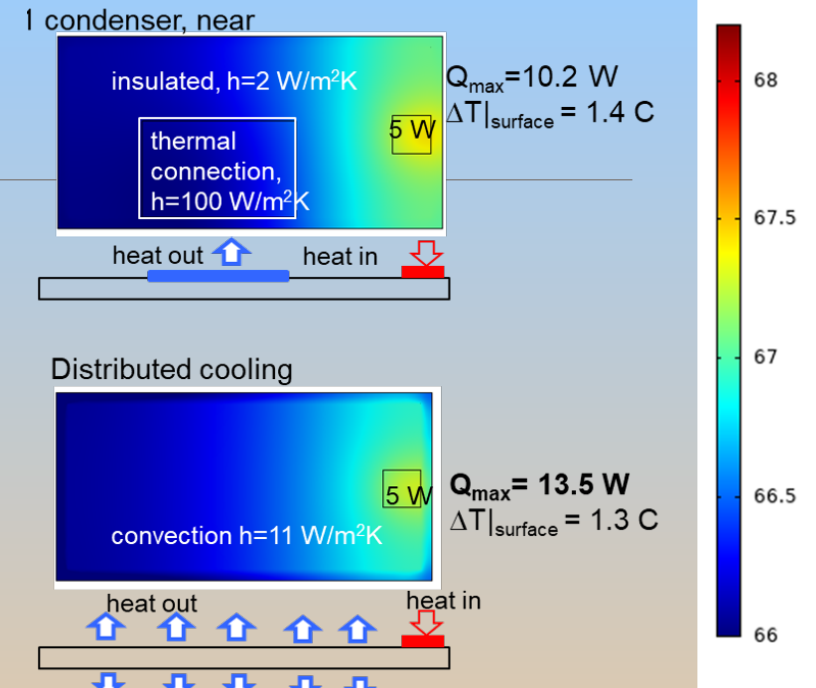
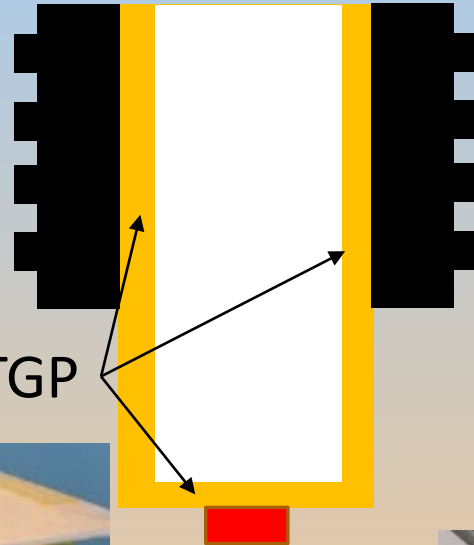
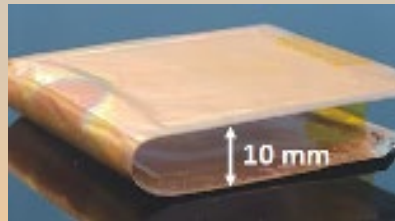
3D VC

Enhance  
Performance?



Reduce cost?

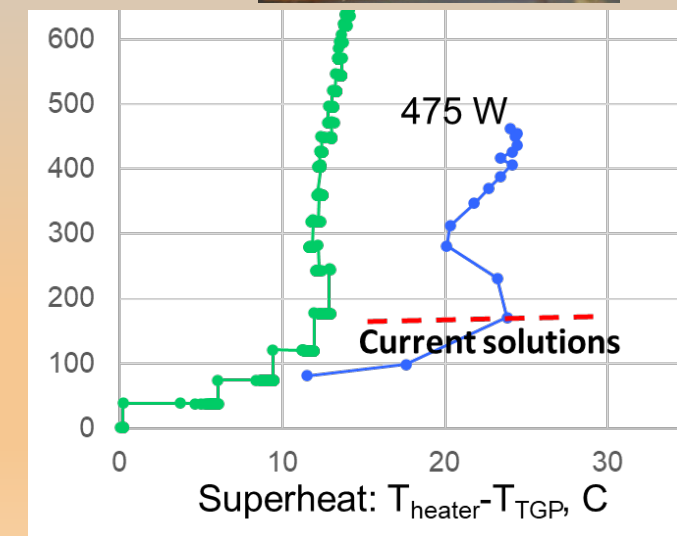
3D TGP



Kelvin Thermal is a leading company for custom-designed TGPs to meet special demands in thickness, weight, size, flexibility, foldability, conformability, heat flux, power, cost, & other requirements.

# Kelvin Thermal: A Leading Company in Vapor Chambers

- First thin and flexible vapor chamber in 2015.
- World's thinnest vapor chamber in 2018 (thinnest even today).
- World's first RF transparent polymer vapor chamber in 2020.
- World's only foldable vapor chamber reaching 200K cycles in 2022.
- World's highest heat flux ( $450\text{W}/\text{cm}^2$ ) vapor chamber for HPC developed in 2022.
- World's lightest vapor chamber in 2022.



# Summary

- Kelvin Thermal is recognized as a leading company in R&D in vapor chambers. Its focus had been on R&D and licensing from 2014 to 2022. Kelvin Thermal is being transformed into a design and manufacturing company with own products being mass produced.
- Kelvin Thermal is establishing two mass production lines with one using a diffusion bonding technology and another one using a laser welding technology. Both scable lines are ready for production with 1000's TGPs per month.
- Kelvin Thermal's vapor chambers known as thermal ground planes (TGPs) offer the following appealing features: low-cost, thin (0.15 - 0.25mm), light (0.05 - 0.15 g/cm<sup>2</sup>), flexible or foldable (bending radius of 10 - 3mm), or large (100 - 1,000mm) for heat fluxes ranging from 1 to 1,000 W/cm<sup>2</sup> and power levels of 0.5 to 1,500 Watts.

