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Graphene Based Heat Spreaders

Comparing Layer Number with Thermal Performance

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Problem and Motivation

PROBLEM: Thermal constraints limit performance

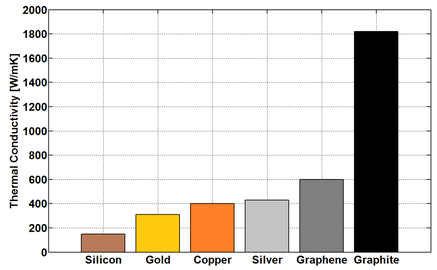
MOTIVATION: Carbon based materials provide promise of next generation cooling solutions

PROCESS:

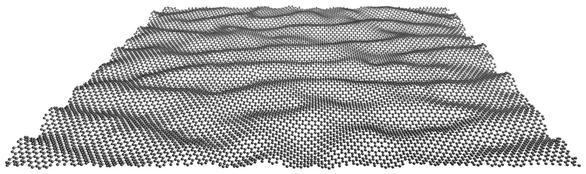
- Examine the effectiveness of creating a heat spreading layer of graphene/graphite
- Quantify the "best" carbon heat spreader
- Incorporate into a top side cooling solution

Why Graphene(ite)?

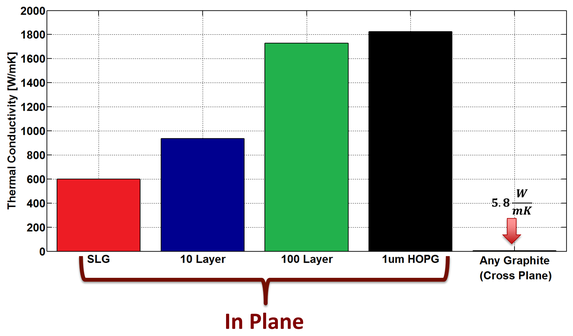
- Carbon is abundant
- Sp^2 carbon is an excellent thermal conductor



Graphene(ite) materials have extremely high thermal conductivities

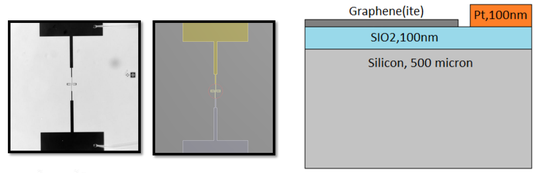


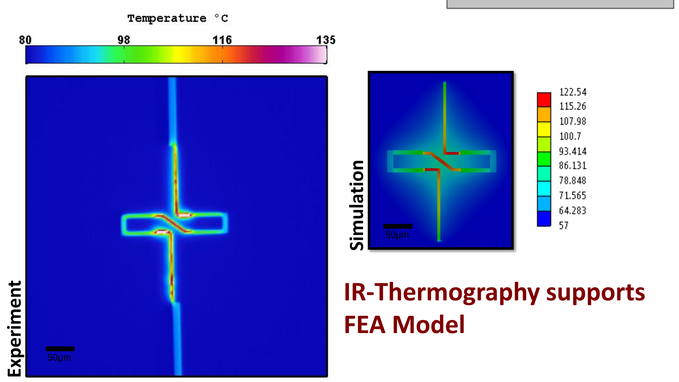
Which Graphene(ite)?



Methods

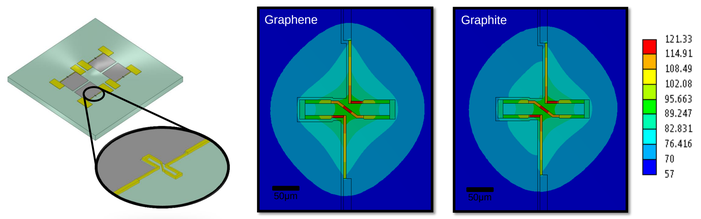
***Goal:** Use experimental and numerical methods to quantify the usefulness of graphene(ite) heat spreaders*





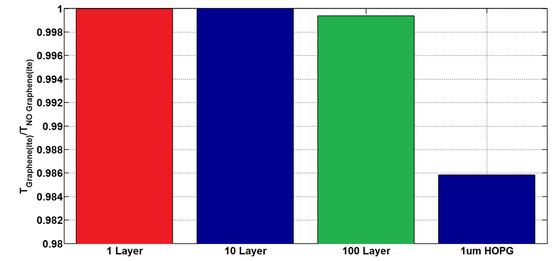
IR-Thermography supports FEA Model

***Goal:** Demonstrate the ability of graphite materials to effectively spread heat*



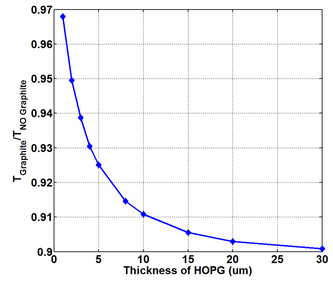
1 Layer Graphene (left) is not as effective as a 1µm HOPG layer (right).

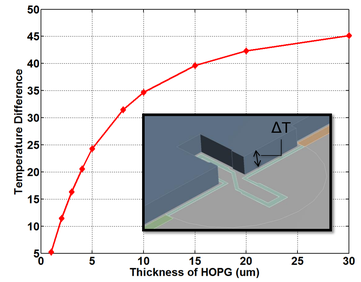
Graphene vs. Graphite



HOPG is much better but change in thermal resistance is less than 2%

Is Thicker Better?



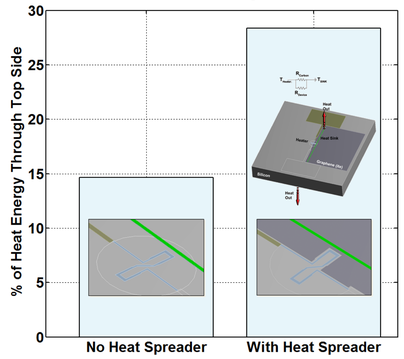


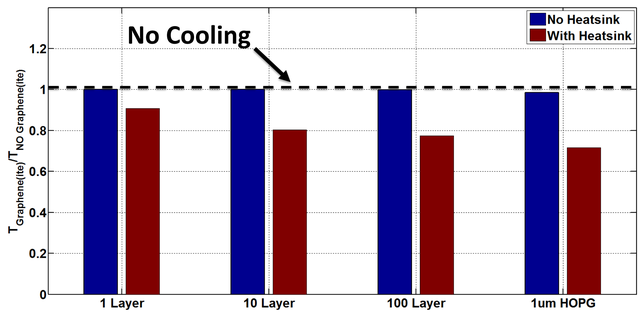
Low cross plane thermal conductivity limits usefulness of increasing graphite thickness.

A Better Thermal Solution

***Goal:** Combine heat spreading with top side sinking to enhance thermal transport*

Sinking alone is not enough. 2x more effective when graphite spreads heat to sink





Takeaways

- Graphite provides most promise to capitalize on high thermal conductivity of sp^2 carbons.
- Combined heat spreading and top side sinking offer a thermal solution possible of a 20% or more reduction in thermal resistance.

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National Nuclear Security Administration

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