PHASE CHANGE MATERIAL TRANSIENT HEATSINK FOR POWER SEMICONDUCTOR

Midterm Presentation 2

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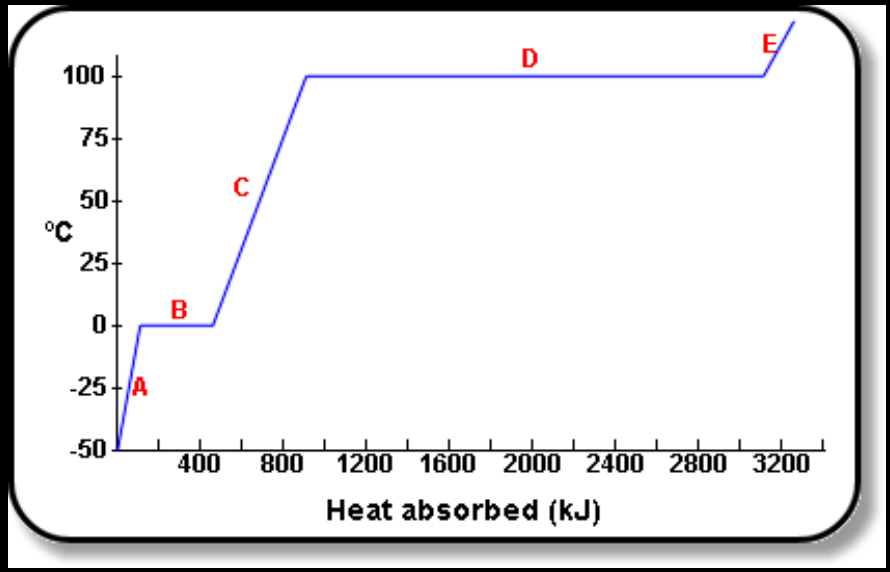
OVERVIEW

- Background
  - Motivation
  - Goal
- Final Design Concept
- Analysis in Comsol
- Prototyping & Testing

MOTIVATION

- New solutions for electronics cooling
- Power Semiconductors
  - Found in jet engine's ignition units and power regulators
- Customer's need
  - A highly-reliable, low-weight heat dissipation solution for power semiconductors



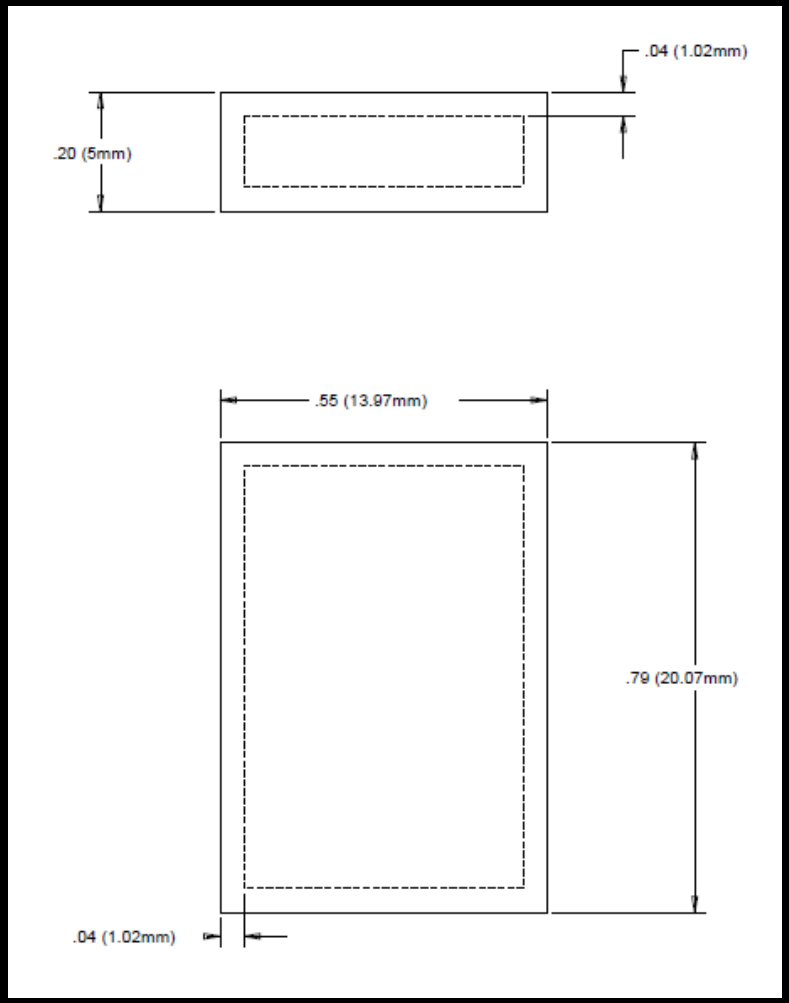
Heat absorbed by 1kg of water

PROJECT GOALS

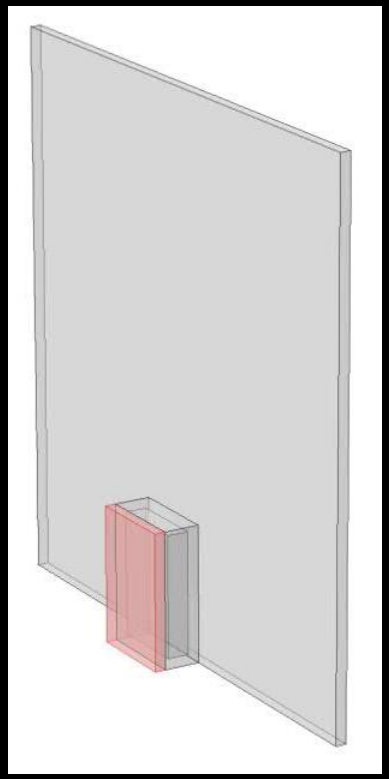
- Create a heatsink containing a Phase Change Material (PCM)
  - Store thermal energy and reject it through natural convection
- PCM
  - Melting temperature within operating range (115-125°C)
  - Able to act as thermal capacitor
- Integration

FINAL DESIGN CONCEPT

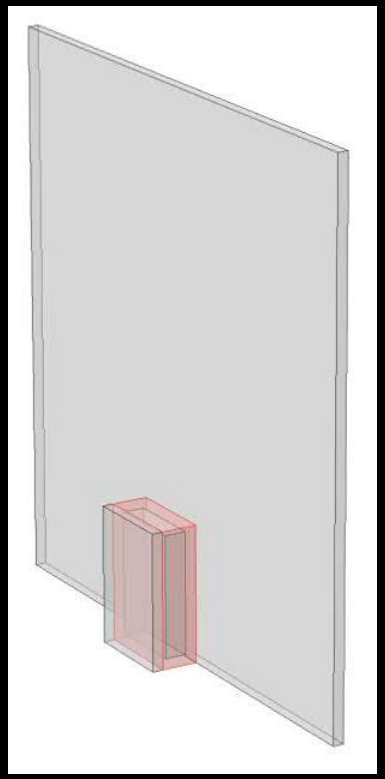
Component	Material
Base	molybdenum
Heat Sink	aluminum
PCM (inside heat sink)	solder
Housing (each wall)	aluminum



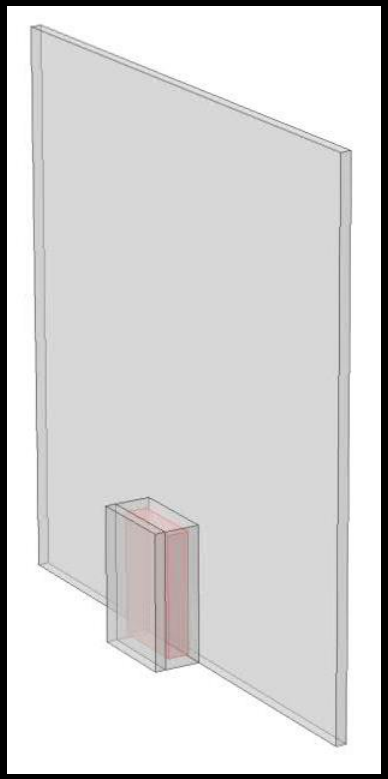
COMSOL MODEL



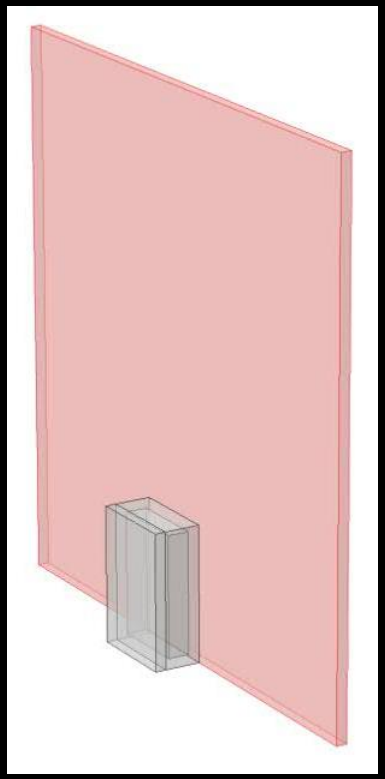
Molybdenum Base



Aluminum Heat Sink

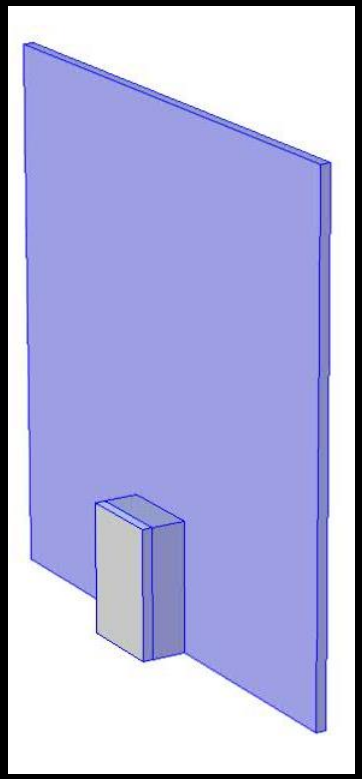


PCM

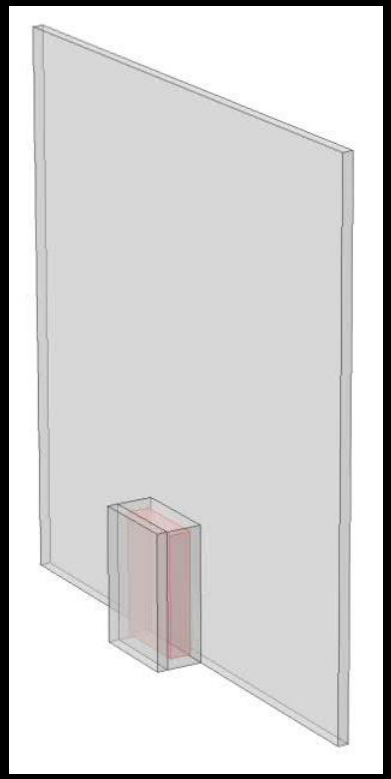


Aluminum Housing

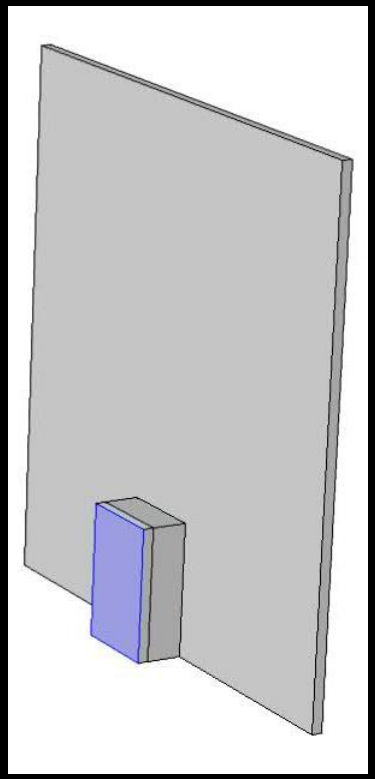
COMSOL MODEL



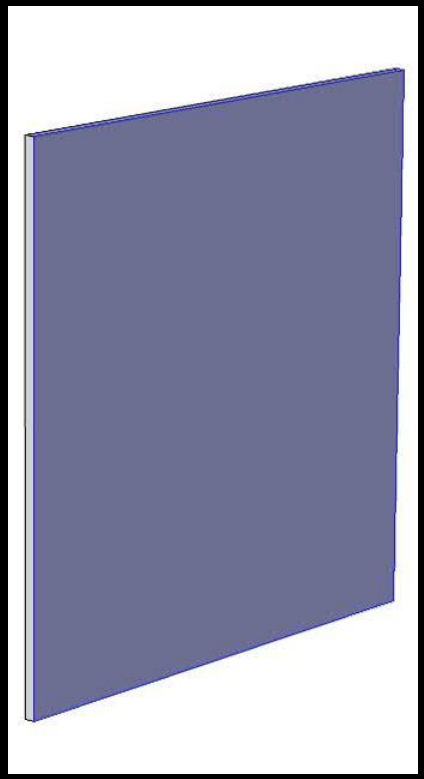
Thermal Insulation



Heat Absorption

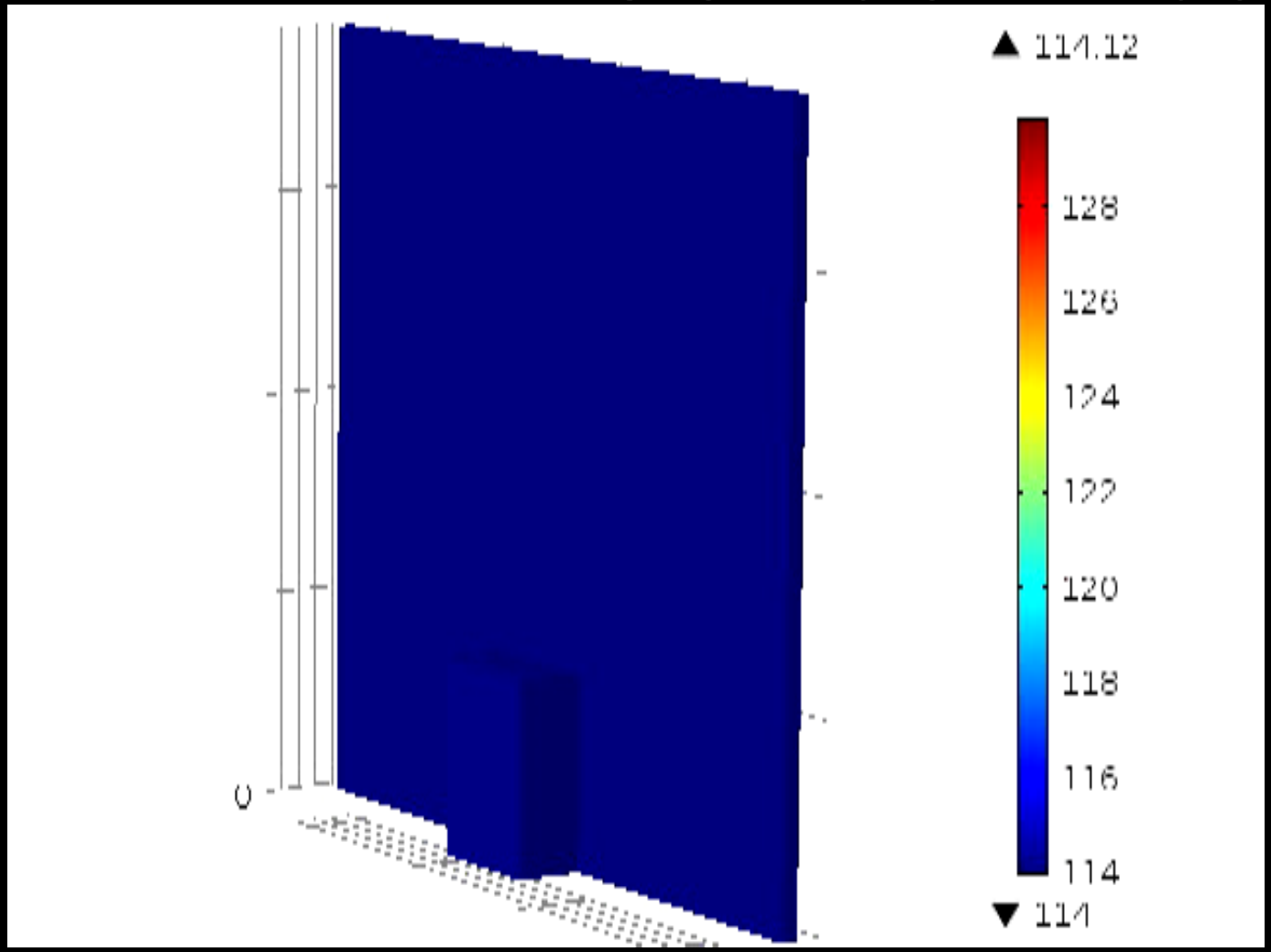


Heat Flux 2W



External Natural Convection

COMSOL RESULTS



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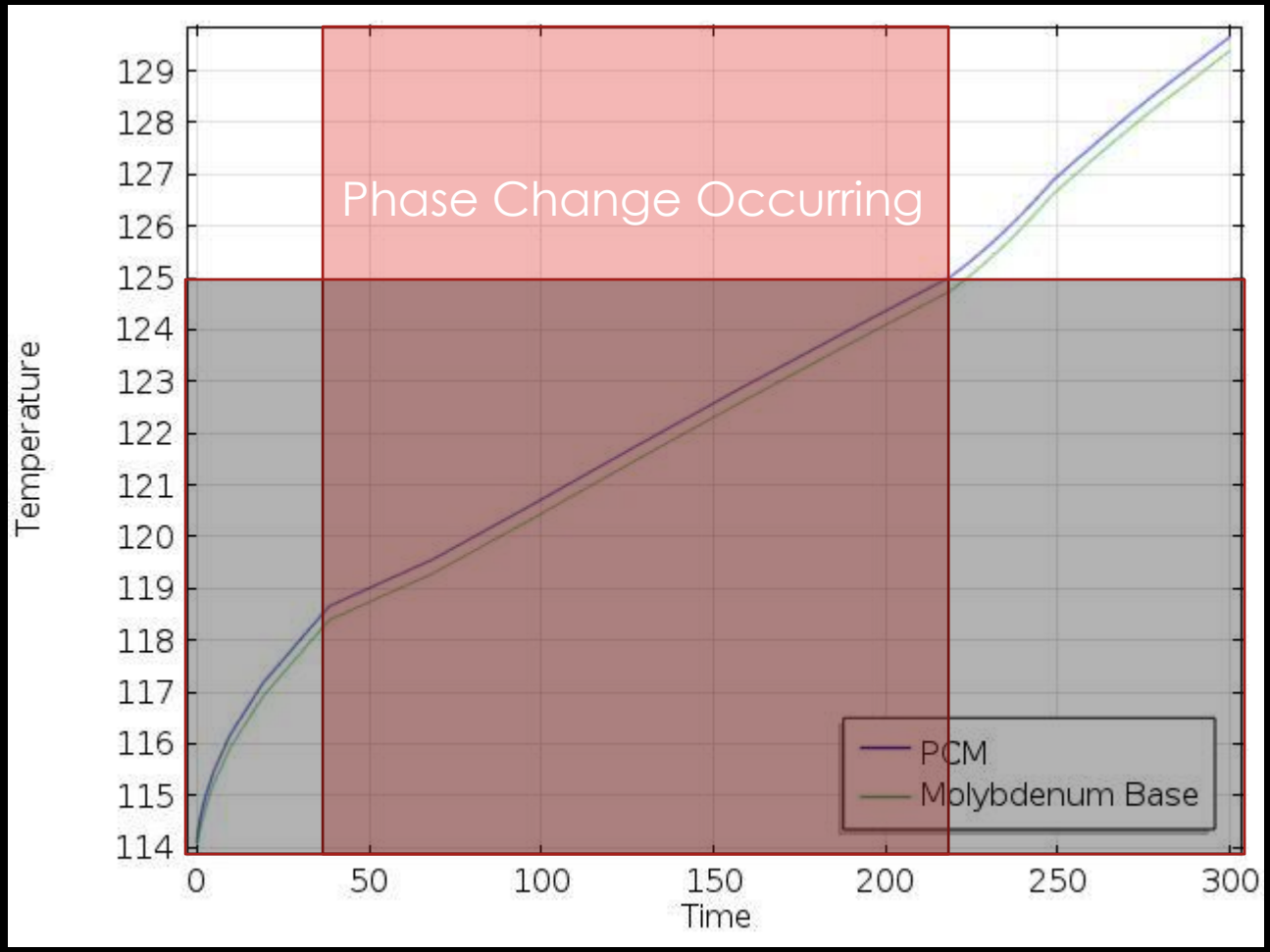

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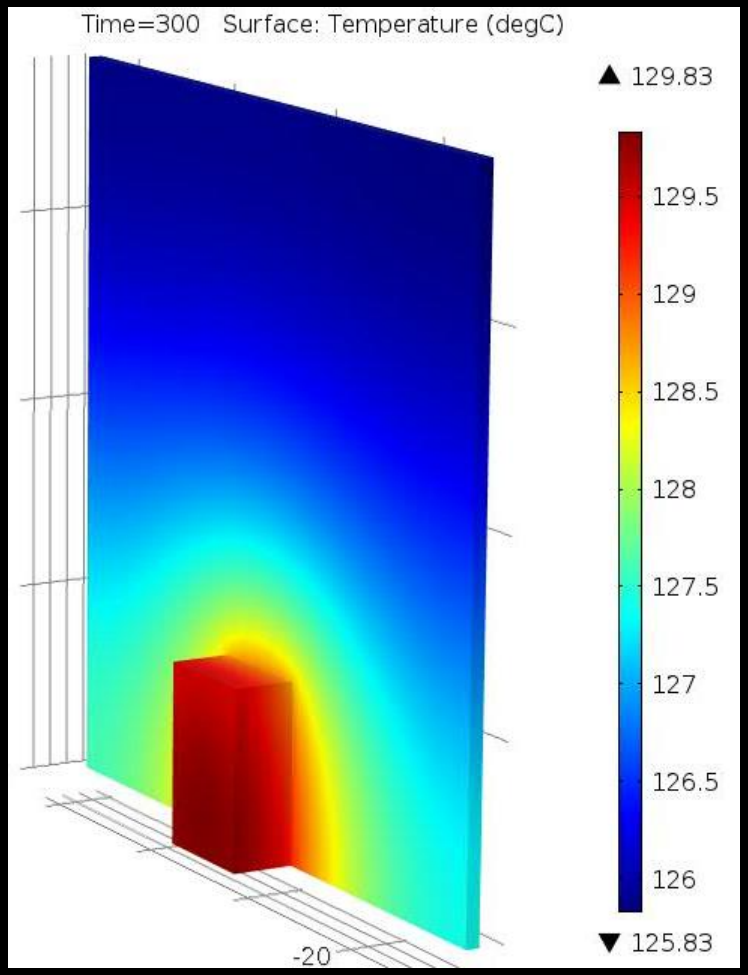
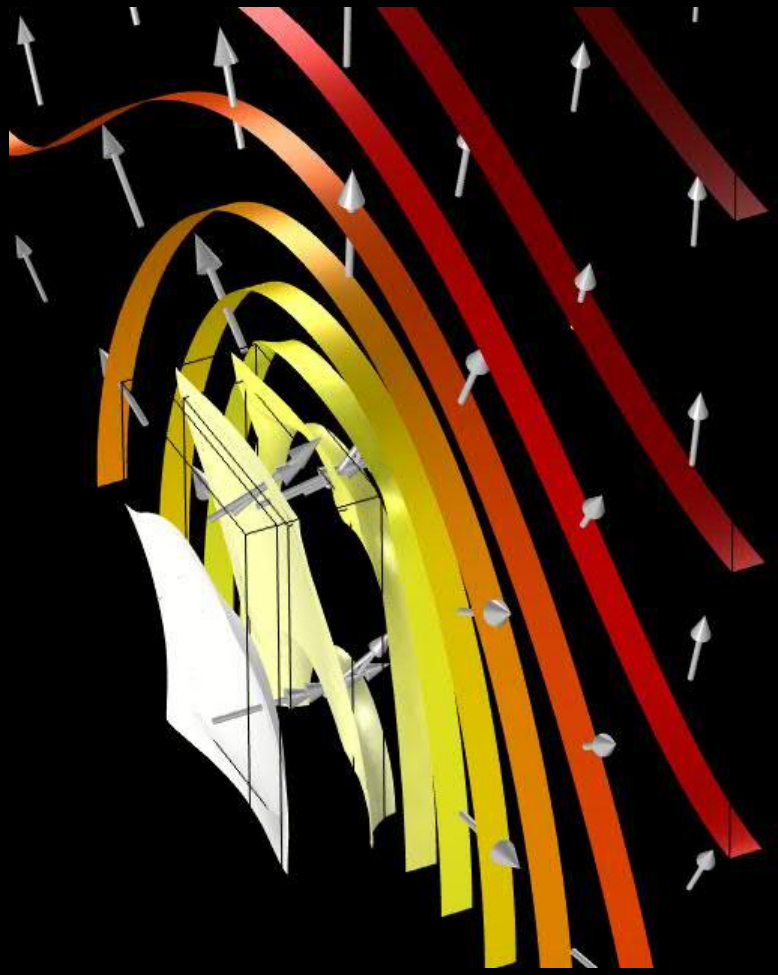
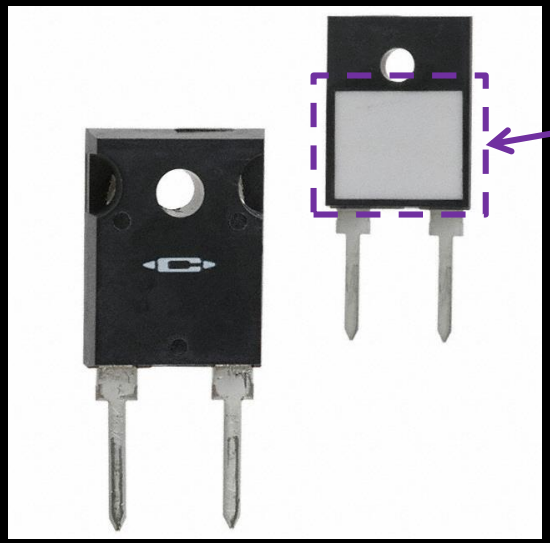
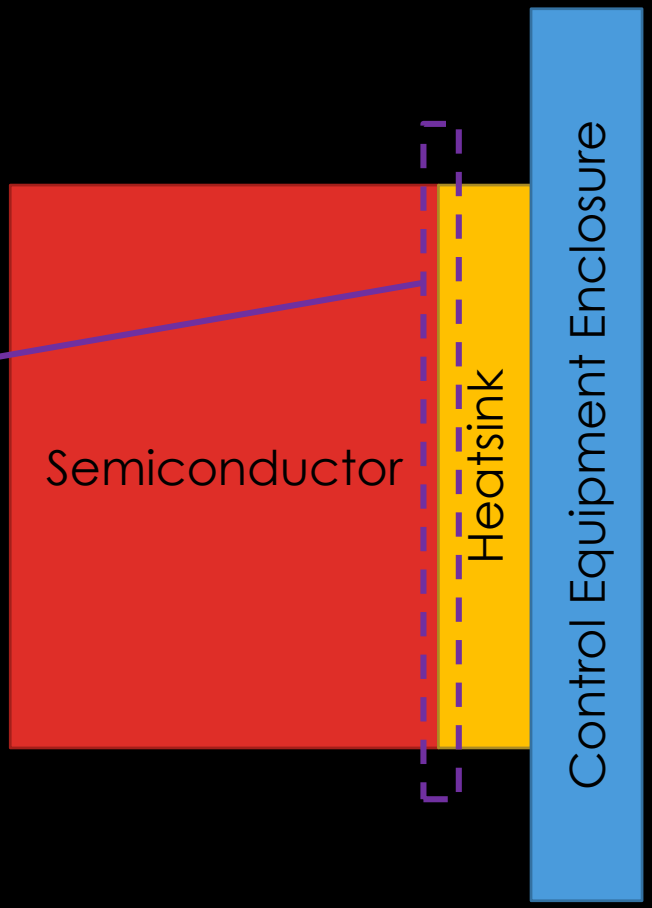




PROTOTYPING AND TESTING

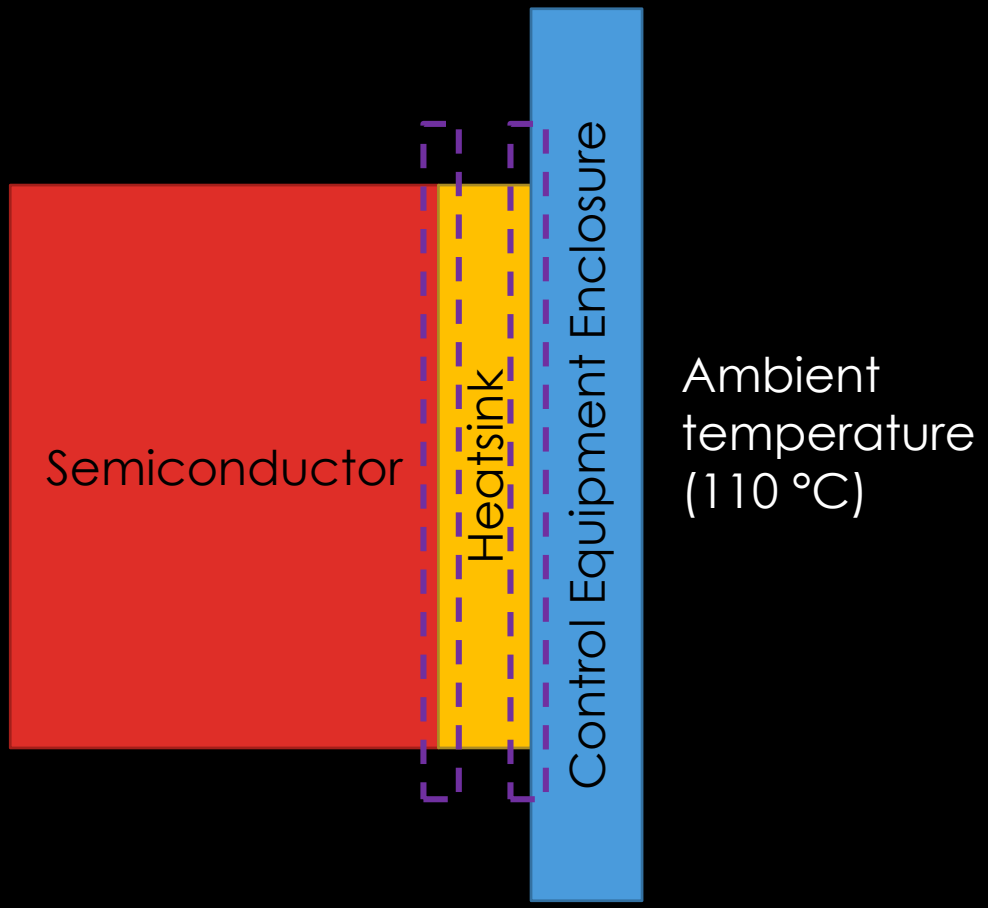
- MP9100 resistor **(Caddock)**: Will use Joule heating to simulate heat flux from semiconductor





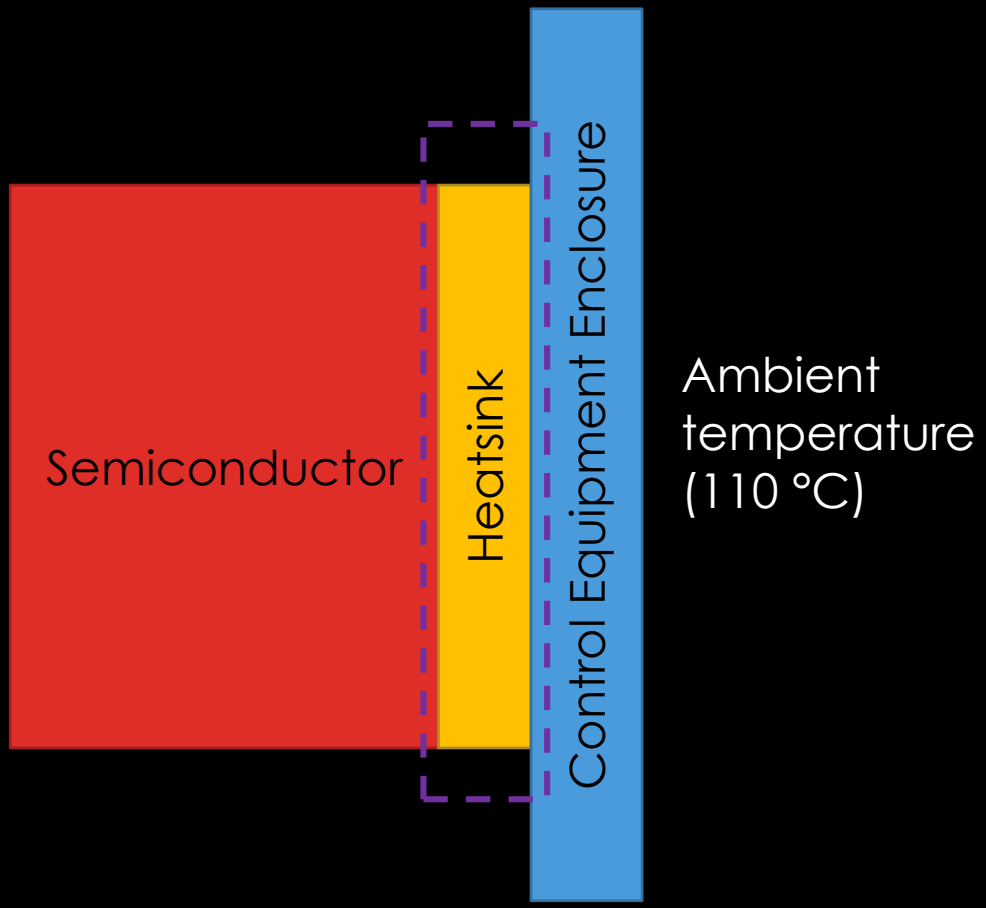
PROTOTYPING AND TESTING

- Hi-Flow 300P **(Berquist)**: Will melt and flow into contact surface imperfections to reduce contact resistance
  - Continuous operating temperature: 150°C
  - Thermal conductivity: $1.6\ \frac{W}{m \cdot K}$



PROTOTYPING AND TESTING

- Heatsink:
  - 52In-48Sn solder **(IndiumCorp)**:
    - Working to obtain free sample size
  - Copper/aluminum tape **(3M)**:
    - Thickness similar to desired wall thickness
    - Easy to shape
    - Easy to assemble
    - Working with sponsor to develop ultimate manufacturing plan
- Aluminum plate:
  - **Unison** will provide plates of specified thickness



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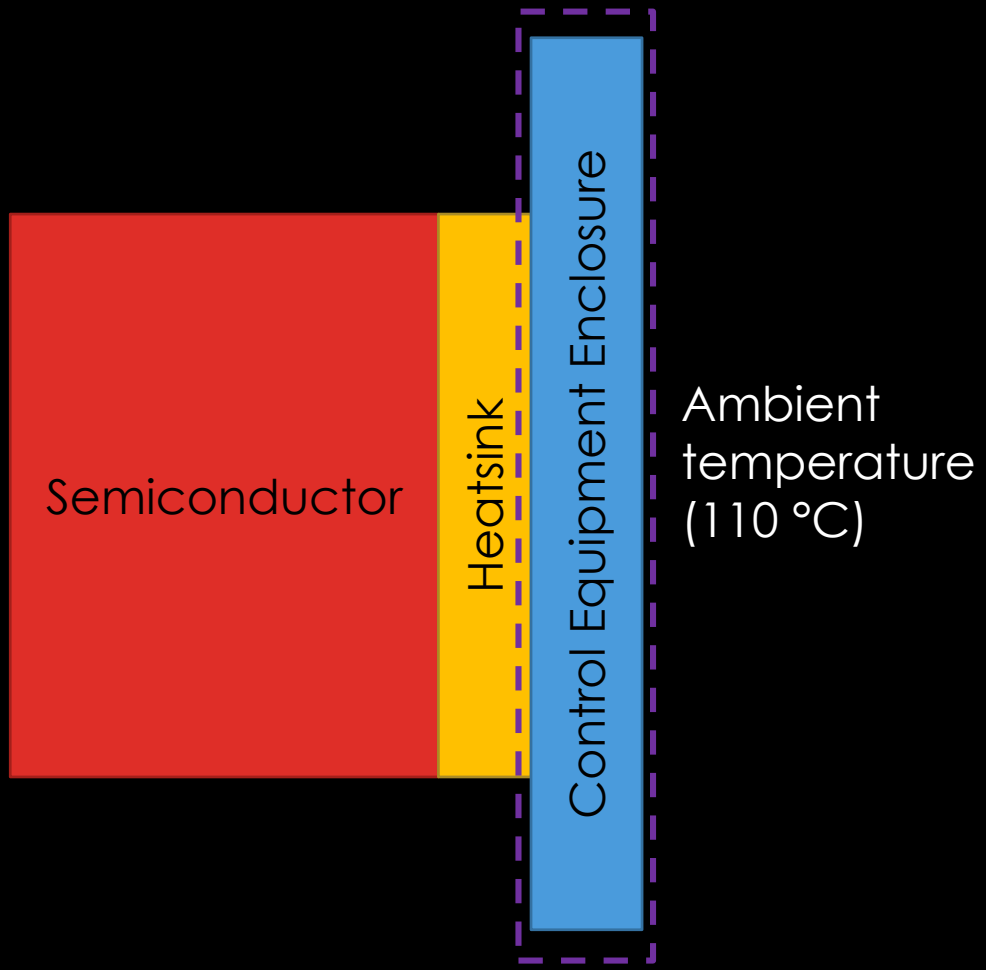
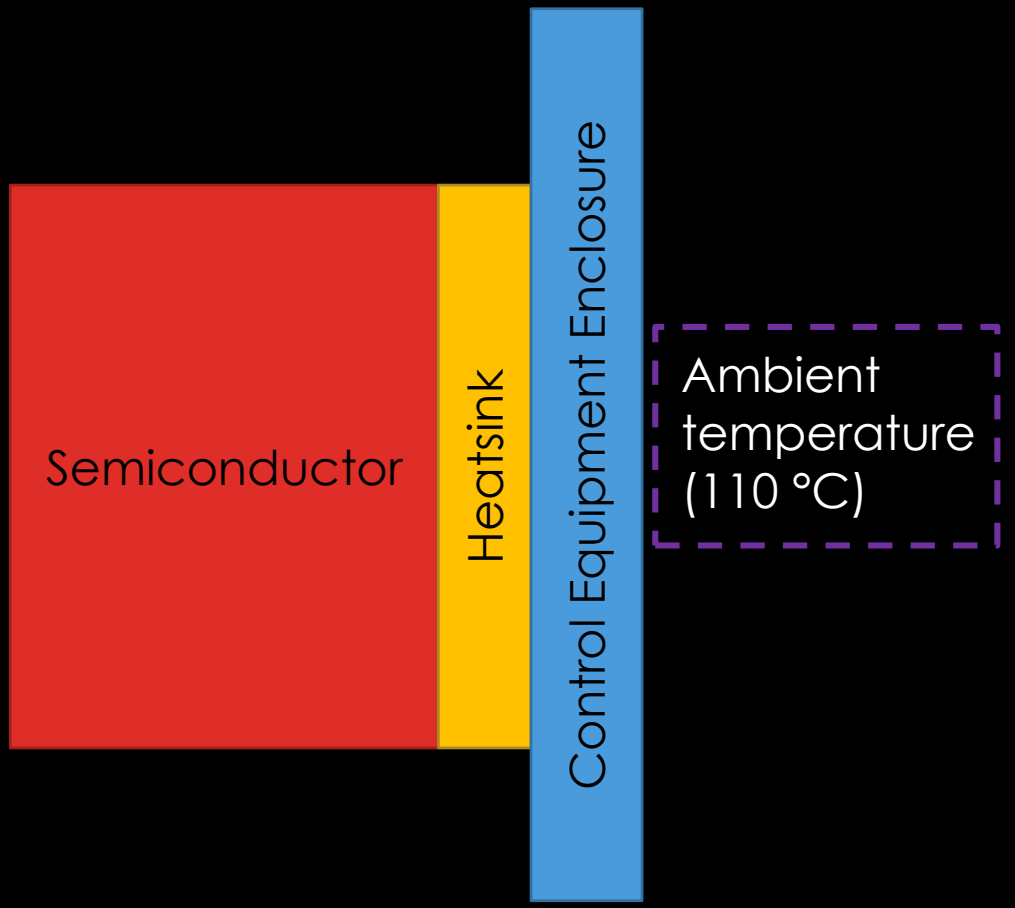


PROTOTYPING AND TESTING

- Test setup will be enclosed in a laboratory oven
  - Type K thermocouples will be used for temperature monitoring
    - Thermal contact tape **(3M)** for mounting
- UX120 **(HOBO)** will be used for data logging
  - Four thermocouple inputs



SUMMARY

- Objective is to create a low-weight, high-reliability thermal management solution for high ambient temperatures
- Accomplishments:
  - Three-dimensional heat transfer model
  - Experimental design
- Future work:
  - Refine COMSOL model
  - Develop final manufacturing plan
  - Procure/assemble/run test setup

QUESTIONS?