Two-Phase Cold Plate

Sponsored by Professor Yoonjin Won

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Executive Summary

A Two-Phase cold plate is designed to use boiling of special liquids to remove heat from heat-generating components. By using both vapor and liquid to extract heat instead of only liquid, our system will be able to extract heat at significantly higher rates, with greater efficiency. We seek to design and build a cold plate to maximize these properties using additive manufacturing and unique internal geometries.

Objectives

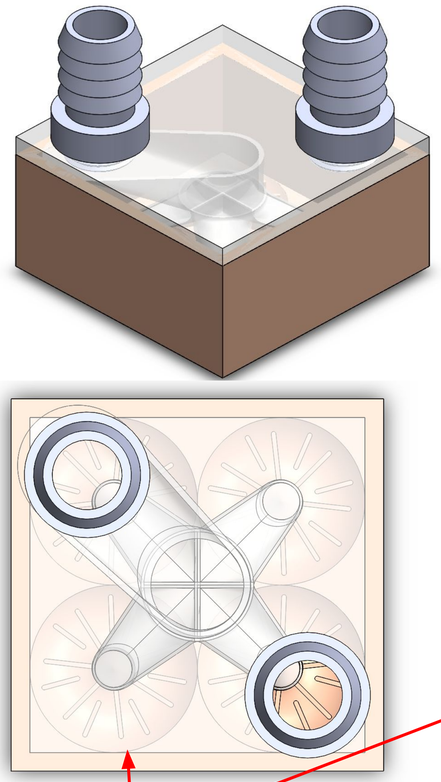
- **Efficient Heat Transfer:** Removes heat from chip using two-phase cooling to prevent overheating without using fans
- **Maximize Thermal Dissipation:** Achieves high thermal energy dissipation in compact spaces
- **Even Heat Distribution:** Reduces hotspots by distributing heat uniformly across components
- **Enhancing System Reliability:** Lowers thermal stress, extending the lifespan of computer chips
- **Optimize Space:** Compact design suitable for dense systems
- **Reduce Noise Levels:** Minimizes need for fans, leading to quieter operations

Electronics

- pressure sensor measuring pressure drop across the cold plate
- power supply
- magnet drive pump, 1 L/min flow rate
- Arduino PID control and data acquisition
  - cartridge heaters producing 300W of heat
  - thermocouples, temperature sensors on heat input and output locations

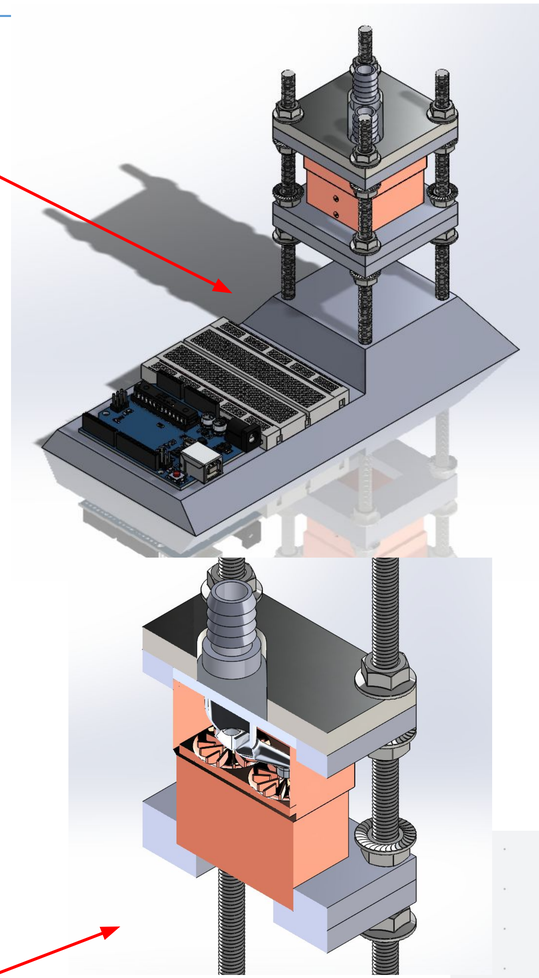
Testing Rig System

- Threaded rods to adjust clamping force
- Flat mounting platform for seamless contact
- Adjustable copper heating block location for applied heat to the designed cold plate
- Arduino data collection and electronics control
- Insulation of heated elements



Internal + External System of plate

- Metal 3D printed copper fin geometry and enclosure
- Resin printed spray nozzles
- CNC milled pipe fittings
- Acrylic top plate for viewing
  - Adhesive at interface



Analysis/Simulation

ANSYS fluid and heat transfer dynamics of internal cold plate design

- test for uniform temperature
- max temperature
- heat flux
- pressure drop

Simulated fluid boiling with measurable heat transfer from the vapor bubbles

Conclusion

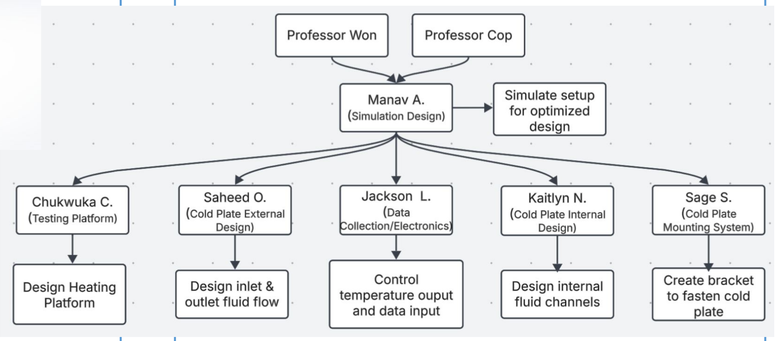
Hardware Performance: Successfully achieve exceptional heat dissipation from two phase cooling to uniformly transfer heat while avoiding hotspots from a controlled heating rig held at a constant surface temperature

MAE 151A Contribution: Initial design of cold plate, testing rig, sensor communication, and temperature control

Recommended Future Improvements: Enhance constant flow of fluid through the cold plate, optimize microstructure for better heat transfer, minimize control error, and reduce costs

Society/Environmental Impact: Reduce need for high energy and multi-component systems to meet the need of dissipating large amounts of heat particularly from processor chips

Team Structure



References and Acknowledgements

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