Dissertation Defense Announcement
Mechanical and Aerospace Engineering Department
University of Texas at Arlington

Advanced Thermal Management Solutions for High-Powered Chips: A Comprehensive Study on Immersion Cooling and Electrochemical Additive Manufacturing-Based Cold Plates

By

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10:00 AM – 12:00 PM, Monday, 12/09/2024

Meeting Link: Teams Link

Meeting ID: 255753795819 Password: yX6tC7AC

Abstract

The increasing power densities in high-performance computing, artificial intelligence, and modern electronics demand innovative cooling solutions beyond traditional air cooling. This study explores advanced thermal management techniques to address the limitations of air cooling in handling high-power CPUs and GPUs. Single-phase immersion cooling, using dielectric fluids, is evaluated as a viable alternative through Computational Fluid Dynamics (CFD) simulations. Forced convection is shown to significantly reduce chip temperatures and enhance thermal efficiency compared to natural convection configurations. Additionally, the study optimizes heat sink designs for immersion- cooled servers to minimize thermal resistance, improving cooling performance for high-density servers.

To further advance cooling technologies, Electrochemical Additive Manufacturing (ECAM) is utilized to fabricate high-precision cold plates with complex internal geometries tailored for chips with non-uniform power distributions. Experimental validation confirms that ECAM-manufactured cold plates with the capability to produce highly intricate and customized internal flow structures achieve lower thermal resistance and superior temperature uniformity outperforming conventional straight microchannel designs. This integrated approach combines immersion cooling, heat sink optimization, and advanced cold plate fabrication, offering a comprehensive solution for managing the thermal challenges of next-generation high-power electronics while improving energy efficiency and reliability in data centers.