Université de Sherbrooke

Design, Fabrication and Characterization of Embedded Vapor Chamber Cooling for High-Density Fan-Out Wafer Level Packages (FOWLP)

Record number : OPR-1180

Overview

RESEARCH DIRECTION

Luc Fréchette, Professeur - Department of Mechanical Engineering

INFORMATION

luc.frechette@usherbrooke.ca

RESEARCH CO-DIRECTION

Amrid Amnache, Responsable de recherche - Department of Mechanical Engineering

INFORMATION

amrid.amnache@usherbrooke.ca

ADMINISTRATIVE UNIT(S)

Faculté de génie
Département de génie chimique et de génie biotechnologique
Département de génie électrique et de génie informatique
Département de génie mécanique
Institut interdisciplinaire d'innovation technologique (3IT)

LEVEL(S)

3e cycle

LOCATION(S)

3IT - Institut interdisciplinaire d'innovation technologique

Project Description

Context:
Advanced packaging technologies are crucial for the evolution of microelectronics, enhancing performance through heterogeneous integration. Traditional methods struggle to meet the demands of high-performance computing, AI, aerospace, and defense. Fan-Out Wafer-Level Packaging (FOWLP) has received growing attention recently due to its high 3D heterogeneous integration capability, small footprint, thin modules and high number of interconnects (I/Os). However, these applications may require dense stacking of thin silicon layers that can lead to thermal management issues. Indeed, thin silicon dies will exacerbate the hot spot effect due to limited spreading capabilities and the molding compound will contribute to thermally insulate the stacked dies. Nevertheless, it is challenging to attach a heat sink to such devices for heat dissipation due to the limited space. The FOWLP package is susceptible to high temperature, which may cause defects of crack, delamination and even failure of the component. Therefore, we propose this thesis project to develop a novel embedded cooling solution to efficiently extract heat in a high-density fan out wafer level package.

Topic:
This thesis aims to develop a vapor chamber-based cooling solution for high-power microelectronics. It involves designing a thermomechanical and fluidic model, optimizing wicking structures to prevent dry-out, fabricating the vapor chamber using advanced bonding techniques, and characterizing its thermal performance. The successful candidate will be in charge of (i) developing an analytical lumped model for thermal resistance at the package level, (ii) designing and simulating the thermomechanical and fluidic behavior of the vapor chamber, (iii) fabrication of vapor chambers using microfabrication techniques, including Si etching and gold-gold bonding, (iv) characterization of thermal performance using a heating element test setup, v) integration of the optimized vapor chamber into an advanced packaging test vehicle and assess reliability. At the end of this thesis, the student will have established a new passive cooling

technology with optimal performance compatible with high-density FOWLP process flow.

Work Supervision:
As part of the IBM/NSERC Alliance Project on Multi-Chip Heterogeneous Integration for High Performance Computing, this PhD thesis will be realized under the co-direction and collaboration of Pr. Amrid Amnache, Pr. Luc Frechette, and Pr. Nooshin Karami. The work will be done mainly at the Interdisciplinary Institute for Technological Innovation (3IT) at the Université de Sherbrooke and at the MiQro Innovation Collaborative Center (C2MI) in Bromont. 3IT is a unique institute in Canada, specializing in the research and development of innovative technologies for energy, electronics, robotics and health. C2MI is an international center for collaboration and innovation in the MEMS and encapsulation field. It is the essential link between applied research and the marketing of microelectronics products. The student will thus benefit from an exceptional research environment that combines students, professionals, professors and industrialists working hand-in-hand to develop the technologies of the future.

Desired Profile:

• Master's degree in mechanical or chemical engineering, micro/nanotechnology, or related fields.
• Strong background in thermal modeling, heat transfer, and fluid dynamics.
• Knowledge of numerical simulation tools (COMSOL, ANSYS, or similar).
• Hands-on experience with experimental thermal characterization.
• Ability to communicate in English or French both orally and in writing
• Strong ability to adapt, be autonomous and work in a team
• Pronounced taste for design, experimental work in a clean room, research and development
• Assets: Knowledge of microfabrication and integration processes, advanced microelectronic packaging

Contact: inpaqt@usherbrooke.ca

Starting date: September 2025
Documents to provide: Cover letter, curriculum vitae, university transcripts, and 2 letters of recommendation.

Discipline(s) by sector

Sciences naturelles et génie

Génie chimique, Génie électrique et génie électronique, Génie mécanique

Funding offered

Yes

$ 25 000 CAD per year

Partner(s)

IBM Canada Ltée., Institut Interdisciplinaire d'Innovation Technologique (3IT), Centre de Collaboration MiQro Innovation (C2MI)

The last update was on 11 March 2025. The University reserves the right to modify its projects without notice.