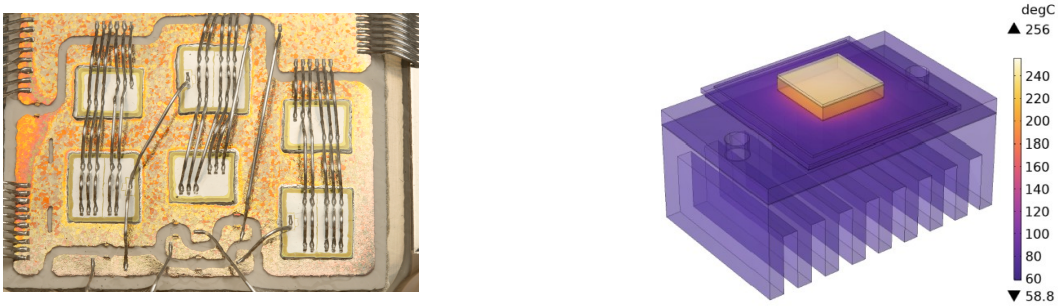
Master project, 2024-2025

Design and realization of overcurrent-resistant chip packages

Supervisors: Nicolas BOTTER, L2EP – Centrale Lille
Yvan Avenas, G2Elab
Email: nicolas.botter@centralelille.fr

Context

The energy sector is currently experiencing a revolution thanks to the increasing share of renewable energies on the grid production. However, those sources of energy produce a voltage which is not adapted to the existing grid, making the use of power electronics mandatory. On its side, power electronics is also experiencing a revolution, made this time possible by the launch of new "wideband gap" SiC and GaN components on the market with much better characteristics than Si components (Figure 1a). These new components represent a major opportunity for power electronics, even if their full use is still limited by a number of obstacles.



(a) (b)

Figure 1: (a) Power electronics layout with Si chips;(b) Thermal simulation of basic assembly in power electronics [1]

When it comes to injecting power into the grid, the main obstacle is the lack of resilience that these components have when they need to deal with grid current surge [1]. In fact, protection circuits present on the grid generally have response times which are longer than the time required for overcurrent to destroy the component. For this reason, one of the key priority of the power electronics sector is to developpe solution to make SiC and GaN components much more resilient to overcurrent. One of the objectives of the L2EP and G2Elab laboratories is to develop innovative packages to find a solution to this challenge.

Objectives

The aim of this research project is to develop and characterize power electronics assemblies with attractive thermal impedances regarding overcurrent.

Firstly, transient thermal simulations will be carried out to study the impact of different materials on the thermal response of the chips. This study will allow the interns to select the most interesting materials for managing transient losses. Subsequently, a thermal characterization experiment will have to be developed with the help of the L2EP laboratory team. Finally, the samples will have to be produced and tested. The results will have to be compared with the state of the art.

Schedule

Motivated candidates apply at the aforementioned email addresses to request an appointment. Latest transcripts should be provided. If the application is selected as part of the master thesis program, then preliminary works will be proposed in the first few months to gradually acquire specific knowledge on the subject. It includes a bibliographic study focusing on loss measurement, and an intermediate scientific project related to simulations and calorimetric techniques. Consequently, the full-time internship in the second semester will take benefit from the former projects and continue toward the aforementioned objectives. The work will take place in the ESPRIT building of the University of Lille.

References

[1] S. Bhadoria, S. G S and H. -P. Nee, "Comparison of Top and Bottom Cooling for Short Duration of Over-Currents for SiC Devices: An Analysis of the Quantity and Location of Heat-Absorbing Materials," in *IEEE Open Journal of Power Electronics*, vol. 5, pp. 765-778, 2024, doi: 10.1109/OJPEL.2024.3407163.