PhD offer – Power electronics

Design and realization of overcurrent-resistant chip packages for renewable energies

Start:	Autumn 2026
Laboratory:	L2EP - https://l2ep.univ-lille.fr/
Team:	Power Electronics
Location:	Campus Cité Scientifique, Université de Lille
Application:	CV, transcripts, recommendation letters if any
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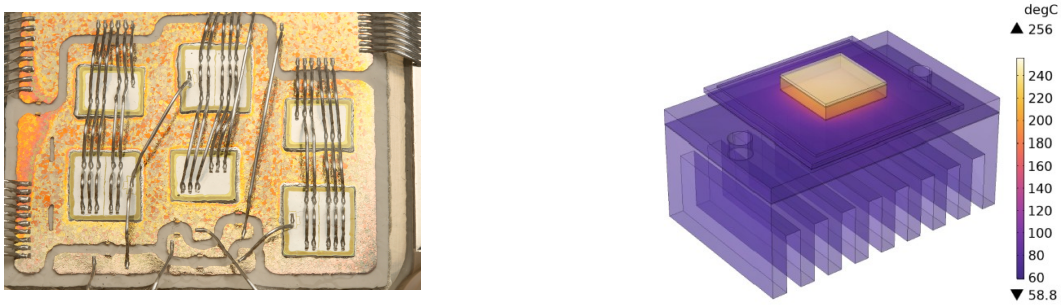
Context

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 converters mandatory. On its side, power electronics is also experiencing a revolution, made this time possible by the launch of new "wide bandgap" SiC and GaN components on the market, enabling the design of much more efficient power converters compared to silicon-based devices (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 module 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 semiconductor devices have when they need to deal with grid current surge [1] [2]. 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 priorities of the power electronics sector is to develop solutions to make semiconductor components much more resilient to overcurrent events. One of the objectives of the L2EP and G2Elab laboratories is to propose and evaluate innovative solutions to this challenge.

Objectives

The aim of this PhD project is to design, fabricate, and characterize innovative power electronics packages for SiC-based components with improved resilience to overcurrent events. The main objective is to develop packaging solutions capable of temporarily absorb high thermal stresses induced by short-duration overcurrents, thereby increasing the robustness of wide-bandgap devices used in grid-connected applications. The work will focus on the integration of new substrate materials developed in parallel by the IMP laboratory (Ingénierie des Matériaux Polymères, Lyon). These substrates are especially expected to offer enhanced thermal inertia compared to conventional solutions. The PhD candidate will evaluate the potential thermal performance gains achievable through the use of those substrates by comparing them with commercial solutions, using experimental characterization and thermal modeling approaches.
In parallel, the PhD work will address the necessary trade-offs associated with the integration of such substrates at the module/converter level. In particular, care will be taken to ensure that improvements in thermal behavior do not lead to unacceptable degradation of other key electrical characteristics. A specific and important aspect of the thesis will be the study of electromagnetic compatibility (EMC). The PhD candidate will therefore investigate the impact of the proposed packaging solutions on EMC and propose design strategies to mitigate adverse effects while preserving thermal benefits.
In addition to performance improvements, particular attention will be paid to the environmental sustainability of the proposed packaging solutions. In this perspective, the thesis will also investigate design approaches enabling improved disassemblability of the power module, facilitating component separation, repair, or recycling at the end of the device lifetime.

Position requirements

As an ideal PhD candidate:

- You have a Master degree with a relevant background in power electronics. Knowledge of thermal engineering will be appreciated also.
- You must have a strong interest in experimental work and simulation.
- You should have obtained excellent study results.
- You should have an interest to work in a team with experts studying different aspects of power electronics.
- This work is included in the framework of a national project, you must be able to make effective reporting to the members of the consortium.
- You should have a strong motivation for scientific writing and for publishing in journals.

Localization and supervision

L2EP is the Laboratory of Electrical Engineering and Power electronic located in Lille – France (https://l2ep.univ-lille.fr/). The Power Electronics group is mostly working on the development of efficient power conversion structures, focusing on wide-bandgap components (SiC, GaN).
G2Elab is the Laboratory of Electrical Engineering located in Grenoble – France (https://g2elab.grenoble-inp.fr/). The Power Electronics groups is interested in the same issues as the Lille team, namely the development of innovative power converters.
The PhD will take place in the ESPRIT building of the University of Lille within the Power Electronics team of the L2EP laboratory. The PhD will be co-supervised by G2Elab.
Finally, this research project is a part of a larger project. Presentations on the scientific progress made during the PhD will need to be given to the various project partners.

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.

[2] Y. Liang *et al.*, "Transient Thermal Characterization and Assessment of Power Module With Encapsulated Phase Change Material Toward Overload Capability," in *IEEE Transactions on Power Electronics*, vol. 40, no. 12, pp. 17563-17568, Dec. 2025, doi: 10.1109/TPEL.2025.3594604.