SUJET de Stage M2 :

A Software Tool to Aid on the Design of the Packaging for Power Electronics

(ref : SATIE_MITSUBISHI)

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Background

Mitsubishi Electric R&D Centre Europe (MERCE) and the SATIE laboratory are collaborating on the topics of reliable and robust power modules.

The Laboratory of Systems & Applications of Information & Energy Technologies (SATIE) is a joint research unit between Gustave Eiffel University (UGE), CNRS, ENS-Paris Saclay, CNAM, Cergy-University, ENS-Rennes.

MERCE is the European R&D centre from the Corporate R&D organisation of Mitsubishi Electric. The aim of our centre is to provide advanced R&D support to the Japanese R&D centres and to the business units of Mitsubishi Electric Corporation.

Internship Description

We are looking for an intern to initiate the investigation on a software tool to aid on the conception of the power module packaging. The intern will work at the SATIE lab and a monthly meeting with MERCE is planned. The software tool to be developed includes an initial mechanical structure to be incorporated in an optimisation routine to be identified. The intern development will be integrated in our current research to develop new reliable and robust power modules.

Technical Background :

In the classical conception and design of power modules, the choice of the materials composing the module are restricted to few references. Nowadays, with the additive manufacturing, the possibilities to build a power module have increased considerably. The stacked structure with a single material per layer can be reviewed and new structures can be designed. At the same time, the range of materials used in the power module packaging are increasing. Soon, the engineers will face a greater number of possibilities to build the packaging environment of the power die, where the constraints will be increased in terms of operating temperature, reliability and parasitic elements. The coupled electro-thermal-mechanic simulations with finite elements are today a reality to explore the reliability of the power modules. These simulations can enable the engineers to decide on the stack-up of the power module, even before to prototype the power module. Nevertheless, the number of parameters to be considered and to be scanned is sometimes high and leads to calculation times which can become prohibitive. It is necessary to implement parameter optimization strategies that will save time without having to do full parameter scans.

Objective & organisation:

The objective is to develop and implement a numerical design tool that will determine the optimal design of a power structure in terms of geometry and materials, with the knowledge of environmental

and operational stresses as an input. For example, it will be a question of determining, for a given generic geometry, the parameters which will make it possible to optimize the structure to make it as efficient as possible with regard to thermal or thermo-mechanical issues.

The internship will take place in the SATIE laboratory, on the Versailles campus of the UGE, and will entail the following tasks:

- State of art on the methodologies for power module design as well as on optimisation methodologies of 2D/3D structures.
- State of art of the materials for power modules with their electrical/mechanical properties.
- Propose a strategy for optimizing a structural design from a FE model
- Build a parametric 2D finite element structure and launch the structure optimisation.
- Final report redaction.

Competences to be acquired before and during the internship

- Knowledge on power module electrical & thermal issues
- Knowledge on the reliability of the power module packaging,
- Knowledge on thermal and/or thermo-mechanical modelling

Prerequisites

- Autonomous, but team player;
- French or/and English: spoken / written.

Duration: 5 to 6 months.

Please send a CV and Motivation letter indicating the Reference of this offer.

References

[1] N. Simpson, D. J. North, S. M. Collins and P. H. Mellor, "Additive Manufacturing of Shaped Profile Windings for Minimal AC Loss in Electrical Machines," in *IEEE Transactions on Industry Applications*, vol. 56, no. 3, pp. 2510-2519, May-June 2020, doi: 10.1109/TIA.2020.2975763.

[2] Nausicaa Dornic, "Élaboration et comparaison de deux modèles de durée de vie des fils d'interconnexion des modules de puissance, l'un basé sur les déformations et l'autre sur les dégradations " Thesis dissertation, SATIE, 2019 - https://www.theses.fr/2019SACLN043