# Design of a double sided liquid cooled SiC phase leg module using ceramic heatsink

**Nicolas BOTTER**

Supervisors: Y. Avenas (G2elab) et J.-M. Missiaen
Co-supervisor: D. Bouvard

**Wednesday, February 2nd 2022 – 10:30 a.m.**

Amphithéâtre rdc GreEn'Er

**Jury :**

| | | | |
|---|---|---|---|
| Jean-François SILVAIN, | DIRECTEUR DE RECHERCHE, | CNRS DELEGATION AQUITAINE | Rapporteur |
| Xavier JORDA | DOCTEUR EN SCIENCES | IMB-CNM Barcelona | Rapporteur |
| Alberto CASTELLAZZI | PROFESSEUR | Kyoto University | Examinateur |
| Fiqiri HODAJ | PROFESSEUR DES UNIVERSITES | Grenoble INP | Examinateur |

**Abstract**: In the context of global warming, public opinion is pushing aircraft manufacturers to reduce the greenhouse gas emissions produced by commercial flights. One possible way of doing this is to increase the share of electricity as a source of energy for the actuators inside the aircraft in order to reduce their weight. However, the components used in power electronics converters are not designed to operate in harsh environments such as aviation. The semiconductor component packages must therefore be redesigned to provide satisfactory levels of reliability.

The objectives of this thesis were to study and develop an innovative power module based on SiC components, sintered silver and ceramic substrates. The feasibility study was carried out in three stages. Firstly, special attention was paid to the optimization of the silver sintering process, as the components and the power tracks of this module are sintered. This optimization was carried out thanks to a novel dilatometric study carried out on silver paste samples with a thickness of around 100 µm. This study was particularly interesting because it allowed access to the sintering kinetics, whereas usually only the final state of the sintered silver is inspected by metallographic section analysis. Next, the physical characteristics as well as the impact of ageing under thermal storage and cycling were studied on simple assemblies in order to select the best combination of materials and manufacturing processes for the final module. Shear strengths of the order of 10 MPa were measured on samples that were subjected to 1000 severe thermal cycles from -50°C to 180°C. Finally, in the last part, the different steps of the power module realization were implemented and allowed the fabrication of functional devices. This device was finally characterized in order to quantify the impact of the whole realization process on the power components. Thanks to those results, a number of improvements were presented to enhance the assembly of future double-sided modules.