Abstract for IMAPS, Thermal 2026, La Rochelle, France

Optimization of PowerModule geometries for EV charging

Jerome Helie, Schaeffler, Toulouse, France

Federico Ghioldi, Federico Piscaglia, Dept. of Aerospace Science and Technology, Politecnico di Milano, Italy

Alexandre Marie, Jean-Pierre Fradin, DepTH-Lab ICAM Toulouse, France

Electrical conversion for electromobility includes AC-DC conversion, DC-DC stages. The associated topologies can be various: B6, Matrix-Dab… but all contains half bridge implementation. Half bridge with High Voltage and Low Voltage MOSFET pair are then typically used, for instance for bidirectional charging – discharging and 12V or 48V supply. In addition, the switching frequency should be large enough to limit the passives size, meaning that switching losses are not anymore negligible in regards of the ohmic losses.

To do so, individual packaging of the MOSFET can be used, but an alternative is to integrate a given number of the MOSFET pairs in one single packaging. The evaluated supplier solutions are all based on Direct Bonded Copper (DBC) technology, see left figure. The dimensions measured (see figure 1) are consistent with the state of the art. This assembly is either filled with a protective gel on the die and bonding; or is completely over-molded around and at the top with plastic.

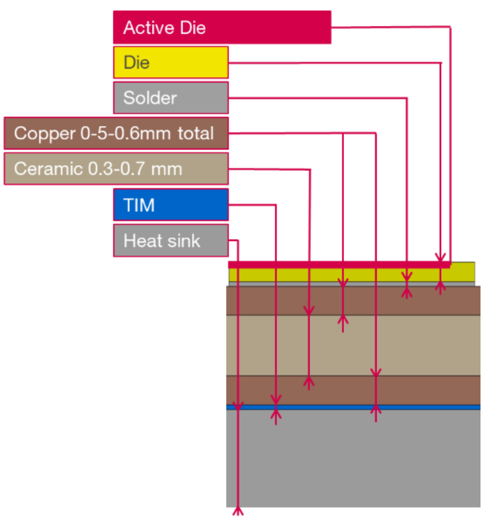

Figure 1: Left: DBC modules cross section.

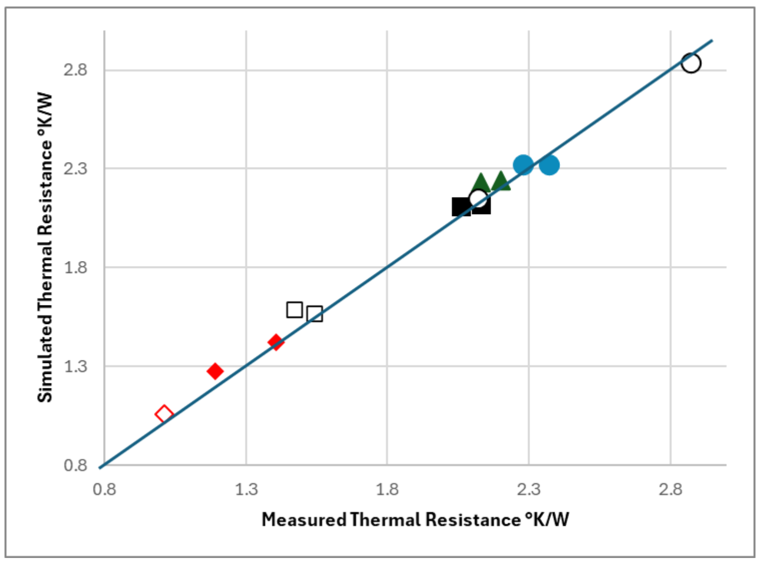

Figure 2: Comparizon model/measure for 4 different modules and different conditions

The objective of the present work is to evaluate the optimal geometry for half bridges, DBC, overmolded integrated power modules. The numerical approach, semi analytic, is validated against experimental measurement with existing prototypes from different suppliers (figure 2).

It is then proposed to optimize a powermodule geometry, keeping the material quantity identical. The proposed approach significantly reduces computation time without compromising precision, providing an efficient and reliable evaluation tool for power electronic assembly optimization.

Refeference:

"Multivariable optimization of pyramidal compound substrates for cooling of power-electronics in modern hybrid and electric propulsion systems", E. Gallorini, J. Hélie, F. Piscaglia, Applied Thermal Engineering, 2023, https://doi.org/10.1016/j.applthermaleng.2023.121368