

Development of a thermo-electrical setup for testing electric vehicle battery interconnections

VPNC Henriques (FEUP, Portugal), MM Kasaei, RJC Carbas, EAS Marques, LFM da Silva

INTRODUCTION

The growing demand for efficiency in electric vehicles (EVs) has driven advances in battery interconnections. However, the increase of electrical resistance with temperature remains insufficiently characterised for emerging joining methods. To address this, a thermo-electrical set-up was developed to study this behaviour in detail. It enables systematic evaluation of resistance-temperature behaviour in two novel joints: hole-hemmed joint, introduced for hybrid busbar assembly [1], and tube-fit joint, designed for cell terminal-busbar connections [2] (Figure 1). This set-up provides the basis for a deeper understanding of their thermo-electrical performance and supports the optimization of next-generation EV battery interconnections.

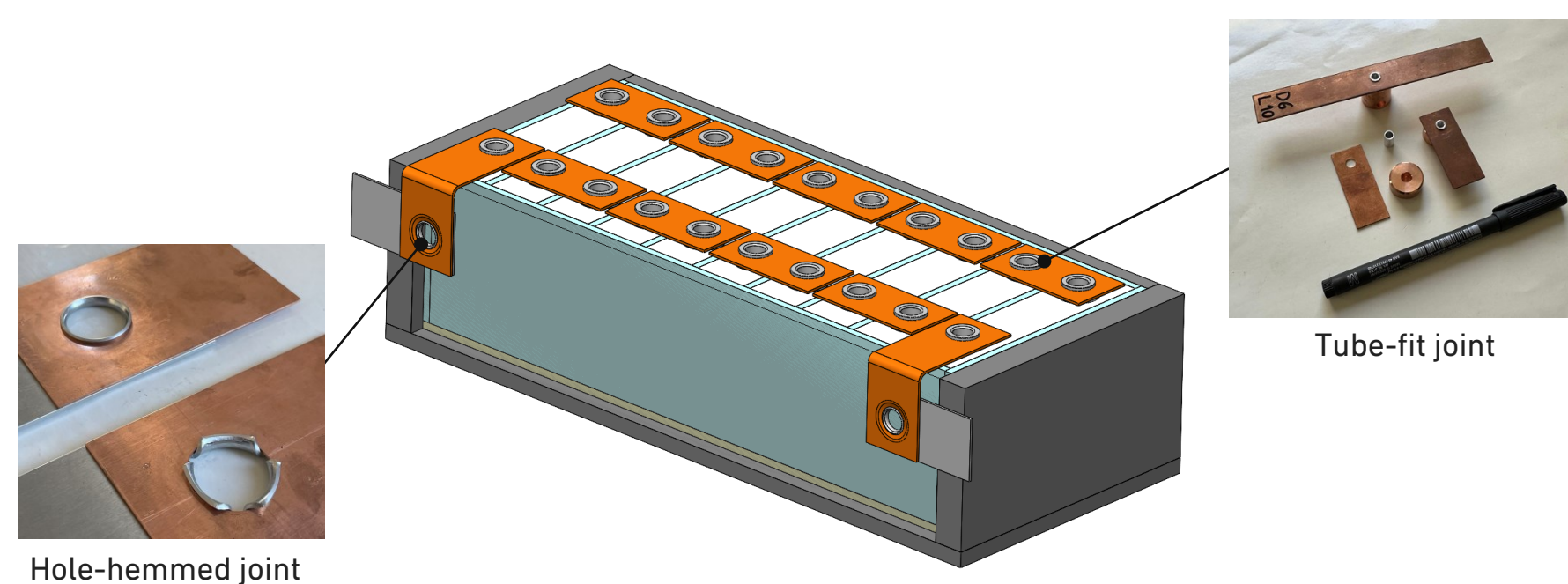


Figure 1– Novel joints developed for EV battery interconnections: (left) hole-hemmed joints between aluminum and copper busbars; (right) tube-fit joints for terminal-to-busbar interconnections.

TEST PROCEDURE

Each joint configuration is subjected to a realistic electrical current to generate Joule heating up to its typical maximum operating temperature. The thermo-electrical set-up replicates these conditions and allows resistance to be measured at controlled intervals during cooling down to ambient temperature.

For hole-hemming joints, a current of about 1500 A is applied until $\approx 105^\circ\text{C}$, while for tube-fit joints, a current of about 600 A is applied until $\approx 65^\circ\text{C}$. These currents and temperature limits represent realistic operating values reported in previous studies [1,2], although they may vary depending on the specific joint design and application.

SET-UP DETAILS

The set-up is mainly composed of a high-current power supply (up to 1500 A), a safety switch component to prevent residual currents during the cooling phase, custom fixtures to secure the specimens, an infrared thermal camera for non-contact temperature monitoring, and a micro-ohmmeter for resistance measurements with a four-wire configuration (Figures 1-4). For hole-hemmed joints, current flows from one busbar to the other (Figure 2), whereas for tube-fit joints it flows from the cell terminal to the busbar (Figure 3). Voltage taps are positioned as close as possible to the joint to minimize the influence of bulk material resistivity, ensuring that the measurements reflect primarily the joint resistance.

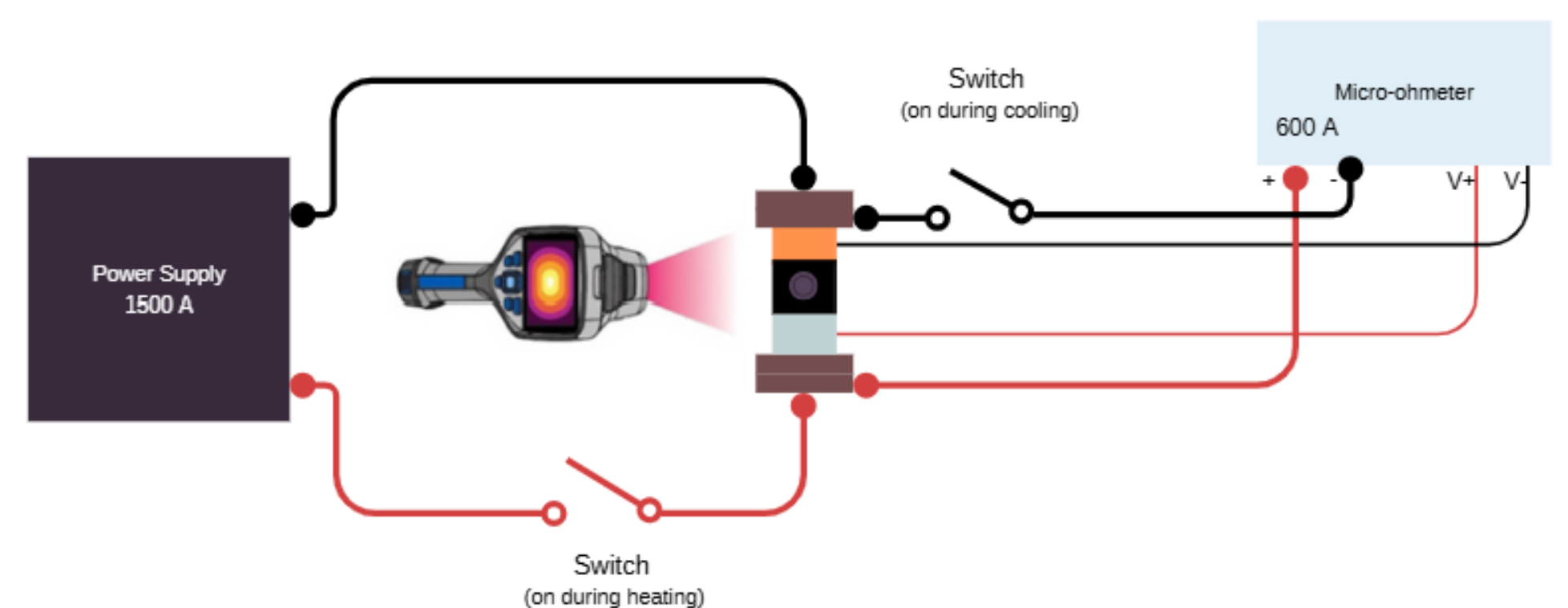


Figure 2– Thermo-electrical set-up schematic for hole-hemmed joint testing.

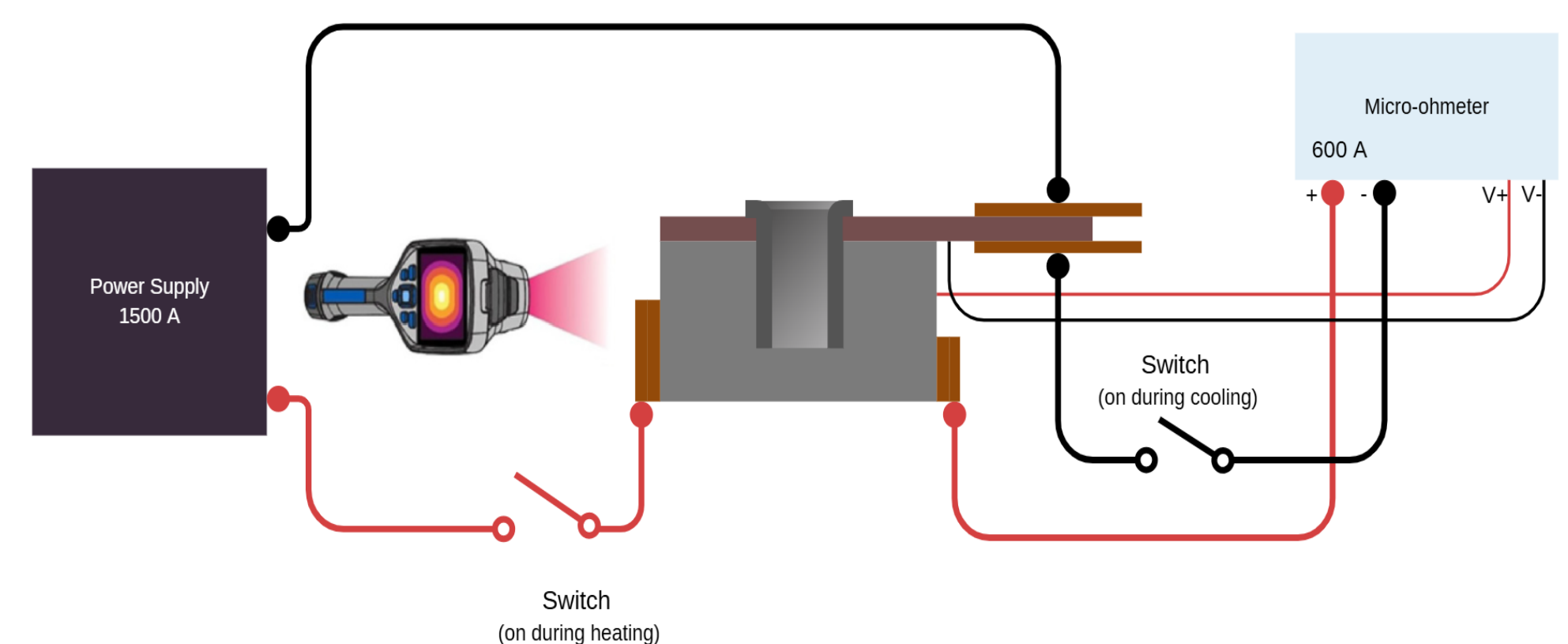


Figure 3– Thermo-electrical set-up schematic for tube-fit joint testing.



Figure 4– Joints mounted in the experimental fixtures: (left) hole-hemmed joint, (right) tube-fit joint.

CONCLUSION

The set-up provides a robust framework for assessing the thermo-electrical behavior of hole-hemmed and tube-fit joints, offering insights to optimize EV busbar interconnections and remaining easily adaptable to future joining processes.

REFERENCES

- [1] D.P.M. da Costa, M.M. Kasaei, R.J.C. Carbas, E.A.S. Marques, L.F.M. da Silva, Thin-Walled Structures, 205, Part C, 112590 (2024).
- [2] V.B. Gomes, M.M. Kasaei, R.J.C. Carbas, E.A.S. Marques, L.F.M. da Silva, Int. J. Adv. Manuf. Technol. 137, 2405 (2025).