Safe-by-Design Approach for High Power / High Energy Battery Systems Using 46xx Cylindrical Lithium-Ion Secondary Battery Cells

Miba Battery Systems

Hartmut Popp[1], Manex Larrañaga[2], René Lang[1] , Iosu Cendoya[2]

1) Miba Battery Systems, 4190 Bad Leonfelden, Austria (hartmut.popp@miba.com)

2) CIDETEC, 20014 Donostia-San Sebastián, Spain

cidetec energy storage

Abstract

- High Energy / High Power architecture using 4695 cylindrical Lithium-Ion secondary battery cells
- Propagation Stop design via (multifunctional) components
- Proven on large module (7.08kWh) level at SOC 96% and 45°C

Safety Aspects

- Miba FLEXCOOLER®, an efficient lightweight cooler, acts also as thermal barrier when applied as sidewall cooler (Fig. 1a))
- Thermal shielding of venting layer by additional burst layer
- Fusing of paralleled cells minimizes currents upon cell short circuit (Fig. 1b))
- Top-weld bottom vent cells allow for dedicated electrical and venting layer

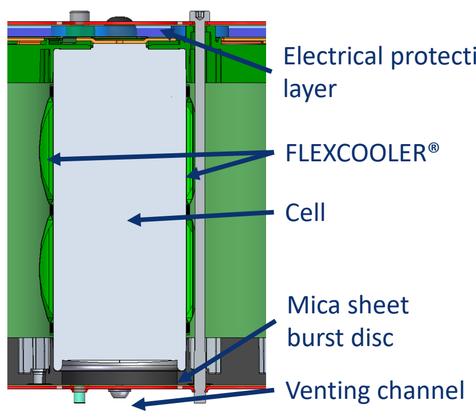

Fig. 1a) FLEXCOOLER® and (thermal) insulation layers.

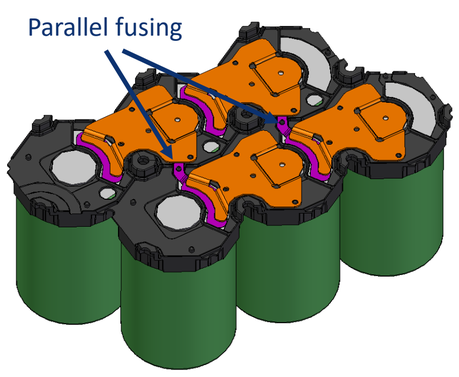

Fig. 1b) 3s2p structure with parallel fusing (purple).

Test Setup

- Module 30s2p resulting in 7.08kWh (Fig. 2))
- Cooling circuit filled but not active
- Module preconditioned to T = 45°C and SOC 96% (=100% net); realistic boundary conditions (venting distance)
- Two trigger cells with heating wire. 1) slow heating 250W 2) rapid heating 350W

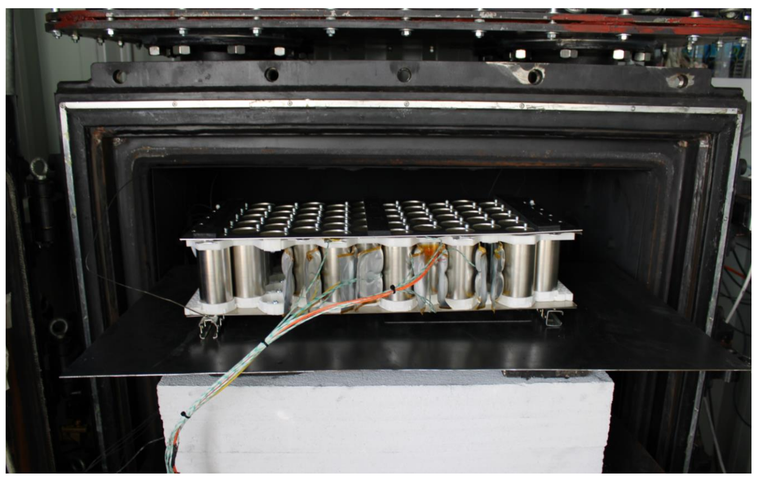

Fig. 2) Module in test chamber.

Results

- Slow and rapid heating did not lead to full propagation
- Slow and rapid heating took 243s and 151s respectively till thermal runaway with nearly equal onset temperature of 129°C and 131°C

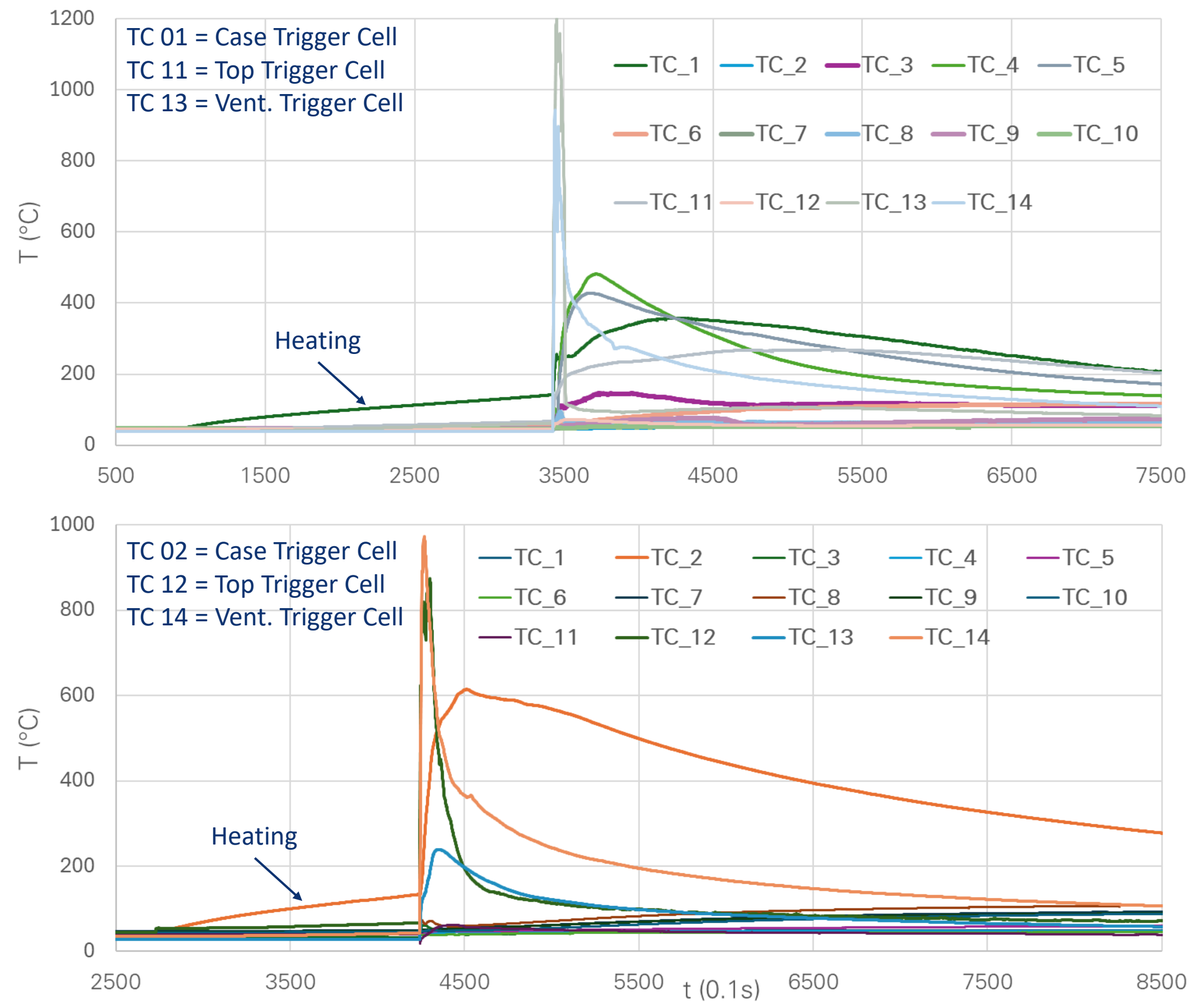

Fig. 3) Temperature progress during runaway of slow (top) and rapid (top) heating.

- Slow and fast heating lead to a propagation of 4 and 1 cell respectively (Fig. 4)
- FLEXCOOLER® still intact; Surrounding cells protected

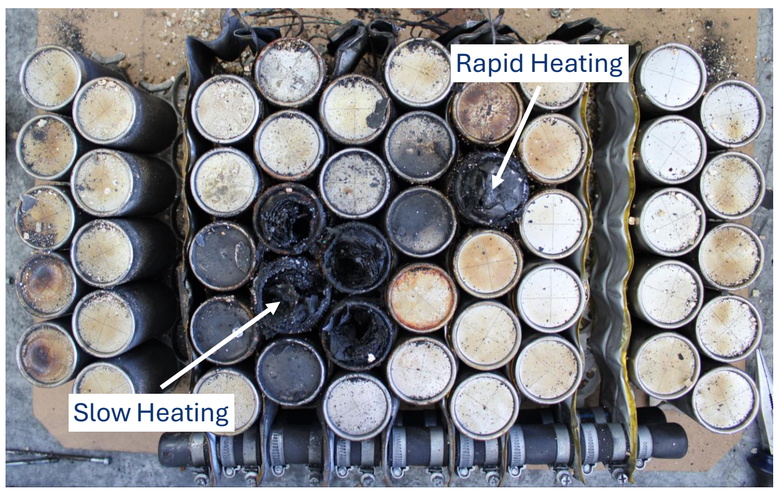

Fig. 4) Post-mortem analysis of module.

Conclusion

- Propagation stop concept successfully validated on large scale module with realistic scenario
- Combination of high SOC with high temperature indicates wide range of safe operation area
- Lower heating more critical as more energy input and surrounding cell temperature increase

Outlook and Next Steps

- Transfer of results to pack level including housing with degassing
- Increase safety by introducing fire retardant and heat absorbent material
- Validation of CFD simulated thermal runaway and propagation events with acquired data from tests

BATSS

Cidetec and Miba received (partial) funding from the European Union's Horizon Europe Programme under Grant Agreement No. 101103821 – BATSS and Miba received funding from Austrian Research Promotion Agency FFG Project Number 899535 – MORE+.

Co-funded by the European Union

FFG Forschung wirkt.