Validated FEM Simulations of Projection Welding for Battery Interconnection

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Introduction

- Energy revolution needs optimised battery storage[1,2]
- Uniform State of Charge (SoC) and State of Health (SoH) in battery modules

→ Low and identical electrical contact resistances[3]

- Projection welding development via Experiments and Finite element method (FEM)

Methods

FEM simulations

- Electrical-thermal 3D global model completely coupled with
- Rotationally symmetric 2D sub model of weld joint
- Phase change included in 2D sub model

Validation

- Welding Hilumin cell connectors on Hilumin cell case using Tungsten electrodes
- High-speed infrared (IR) camera → temperature
- Cross section analysis of joint→ weld nugget size

→ Two parameters for validation

Results and Discussion

- Validation experimental methods work precisely
- Simulation in good agreement with temperature distribution / weld nugget size
  - Strongly dependent on surface roughness and contact area
  - Adding mechanics → material deformation → more precision

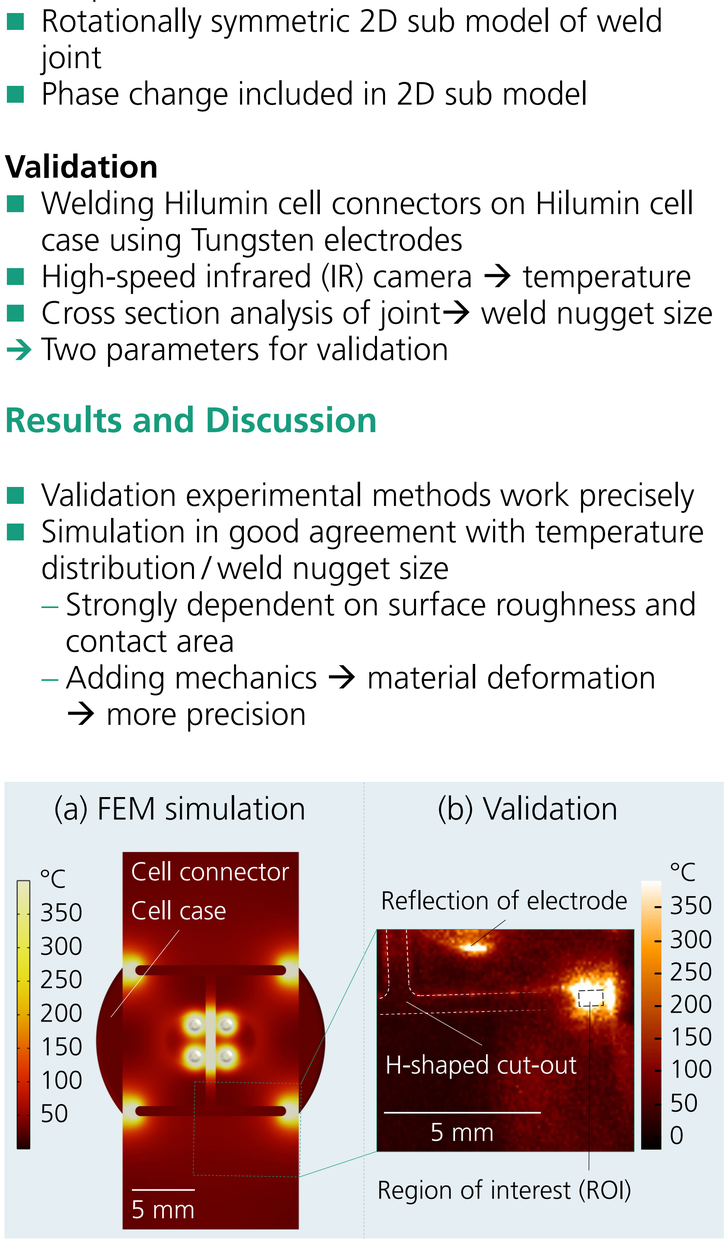


Fig. 1: (a) FEM temperature distribution after 10 ms welding. (b) Experimental temperature distribution after 10 ms welding.

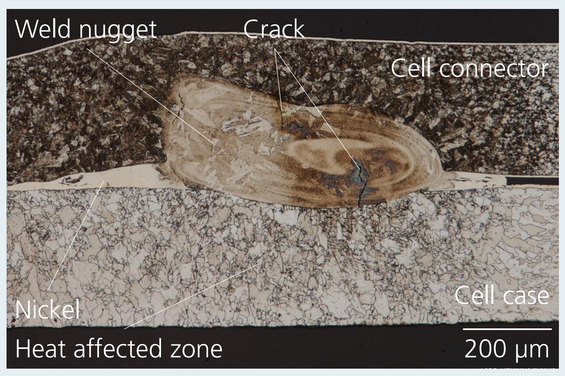
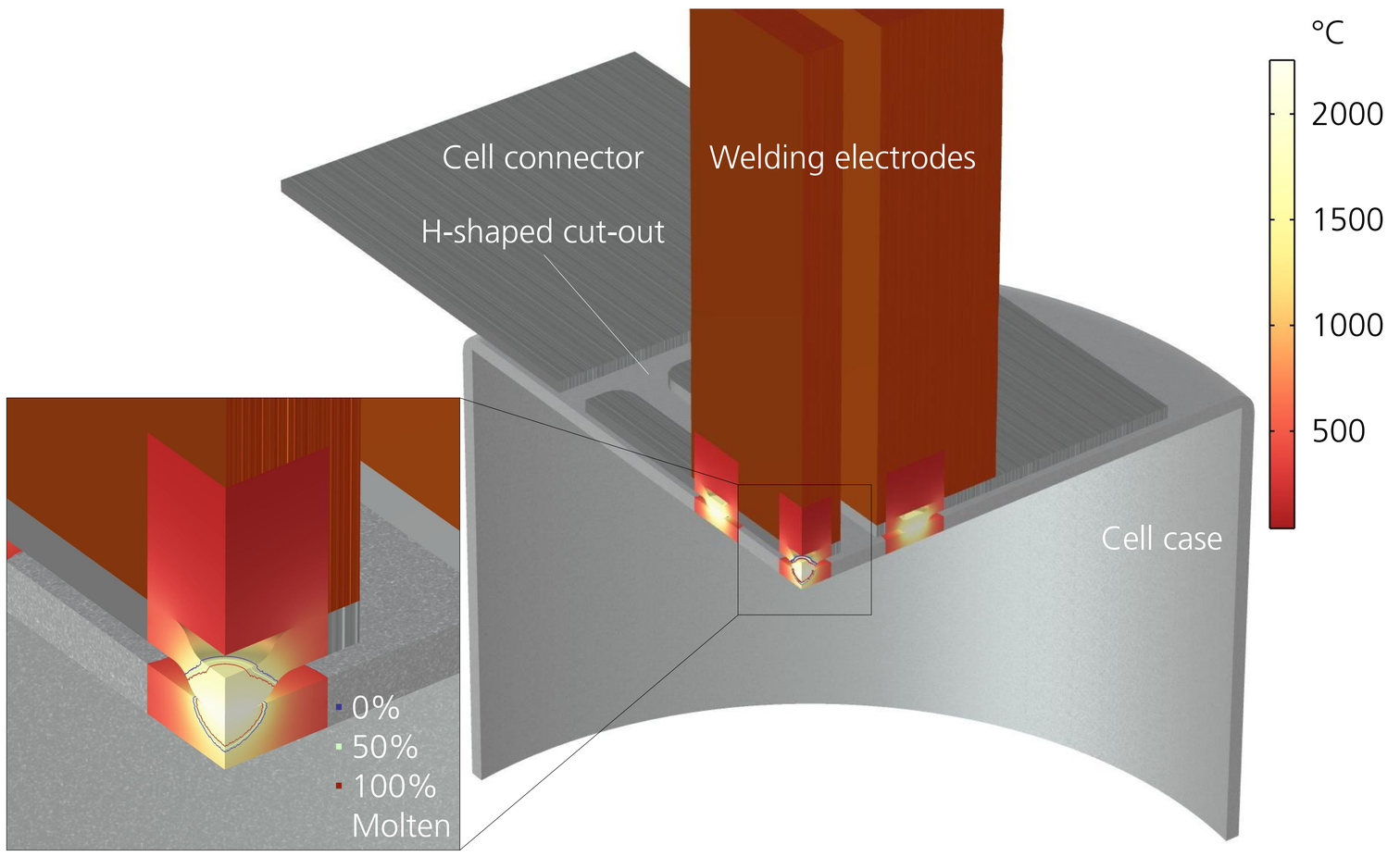


Fig. 2: Cross section of projection welded joint. The grain structure is made visible with nitric acid solution.



Our electrical-thermal FEM model accurately simulates the projection welding process for the interconnection of batteries.

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[1] Brandes, Julian *et al.* (2021): Wege zu einem klimaneutralen Energiesystem. Fraunhofer ISE. https://www.ise.fraunhofer.de/content/dam/ise/de/documents/publications/studies/Fraunhofer-ISE-Studie-Wege-zu-einem-klimaneutralen-Energiesystem-Update-Klimaneutralitaet-2045.pdf, zuletzt geprüft am 24.06.2022.
[2] IPCC, Ed., "Climate Change 2022: Mitigation of Climate Change," 2022. Accessed: Jun. 24 2022. Available: https://www.ipcc.ch/report/ar6/wg3/
[3] Wu, Billy *et al.* (2013): Coupled thermal–electrochemical modelling of uneven heat generation in lithium-ion battery packs. In: Journal of Power Sources 243, S. 544–554. DOI: 10.1016/j.jpowsour.2013.05.164.

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