COMSOL CONFERENCE
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Temperature propagation during cell stacking processes for lithium-ion cells

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EWE-Forschungszentrum für Energietechnologie e.V.

Summary

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- Introduction / Productions processes during battery stack assembly
- Modeling Approach
- Numerical Model (COMSOL Multiphysics®)
- Experimental Study and Simulation Results
- Validation
- Short-term Thermal Treatment / Laser welding
- Conclusions and Outlook
- Acknowledgements

Productions processes during battery stack assembly

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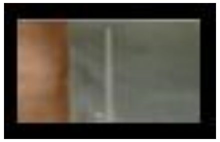
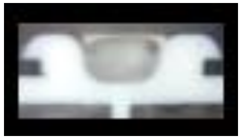
Elevated temperatures on the cell surface influences the cell behavior (capacity loss, power fade, safety risks) negatively

Welding	Bonding	Pretreatment



Laser welding



hot staking

plasma pretreatment

ultrasonic joining

Hot gluing

UV curing

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Modeling approach

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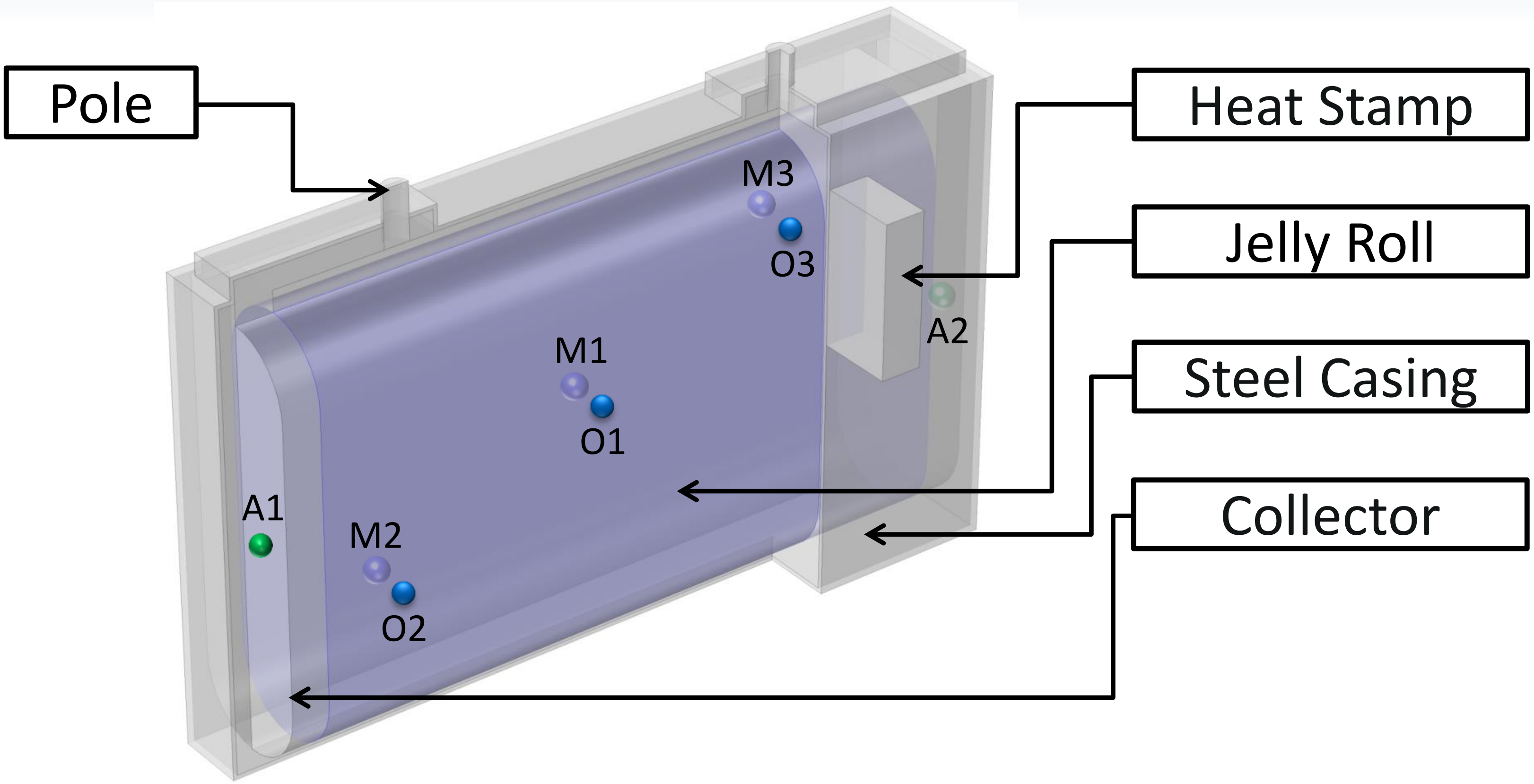

- 3D cell geometry of the simulated Li-ion cell with thermal sensor spots

Numerical Model (COMSOL Multiphysics®)

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- Heat transfer equation: heat generation and conduction

$$\rho\, C_p \frac{\partial T}{\partial t} = \mathrm{div}(\lambda\, \nabla T) + Q$$

- Material relationship of heat capacity, heat conductivity and density

$$\lambda = \alpha\, \rho\, C_p$$

- Boundary conditions represent natural convective cooling with a heat transfer cofficient h and a heat load as a space-homogeneous time dependent temperature function g

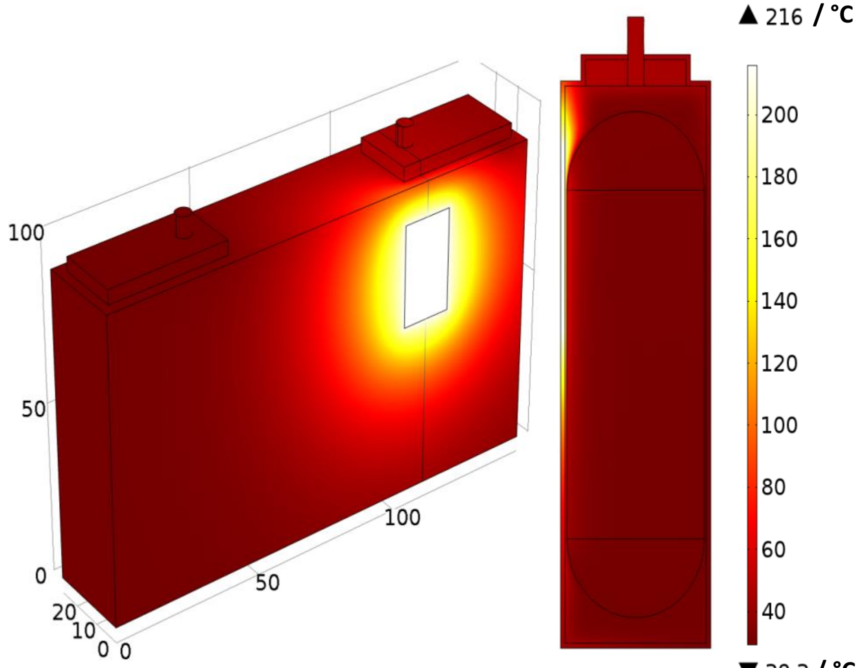
$$-\lambda\, \nabla T = h\,(T - T_{ext})$$

$$T = g$$

- Comsol Interfaces: “Heat transfer module“ and “CAD Import module“

Experimental Study and Simulation Results

Thermal stressing with the heat stamp for 60 s at a heat rate of 50 W



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- Temperature distribution [°C] in a prismatic cell at the experimental setting

Validation

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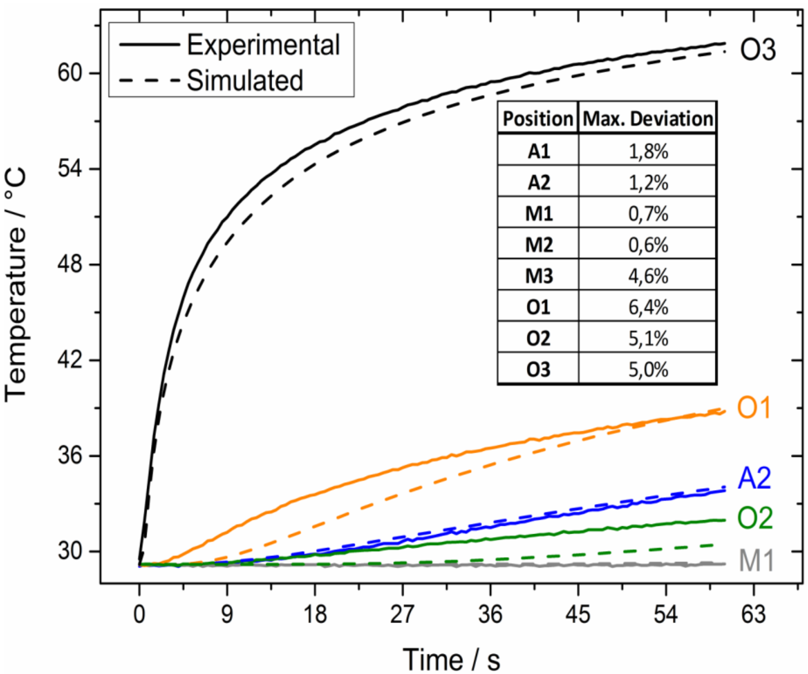
Simulated data vs. Experimental data → good agreement



Position	Max. Deviation
A1	1,8%
A2	1,2%
M1	0,7%
M2	0,6%
M3	4,6%
O1	6,4%
O2	5,1%
O3	5,0%

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- Temperature profiles and simulation errors for the experimental validation

Short-term Thermal Treatment / Laser Welding

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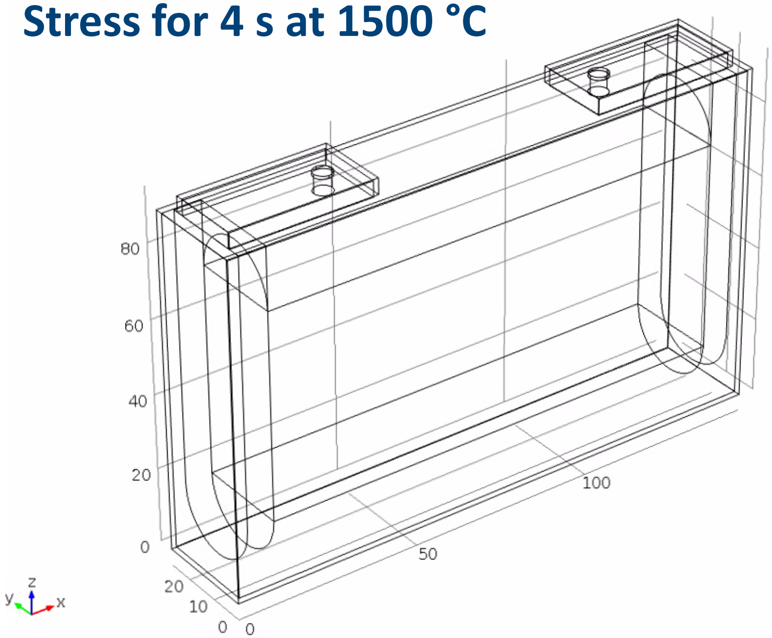
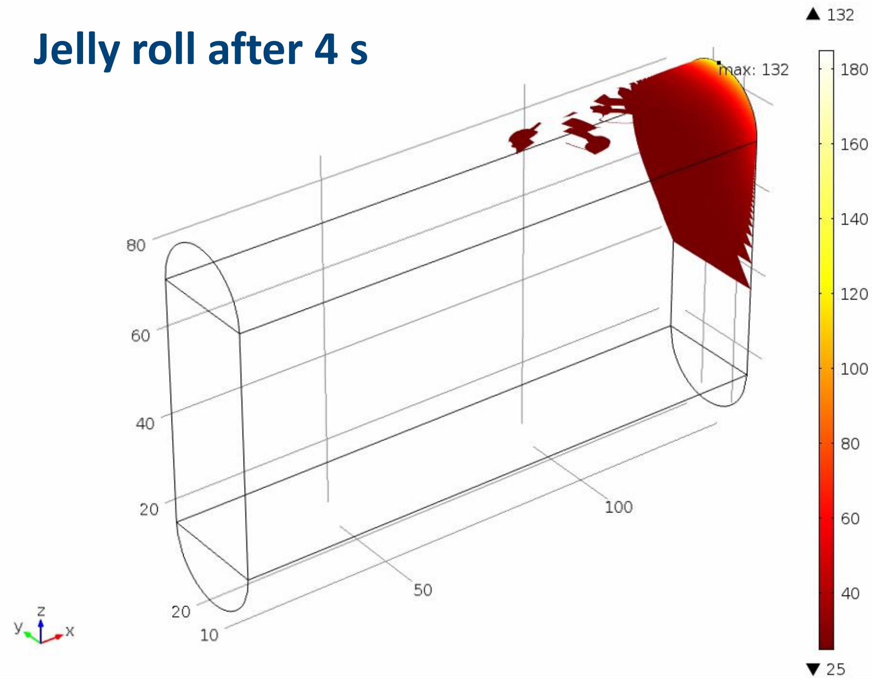
A local peak temperature of 180 °C is reached at the jelly roll

Stress for 4 s at 1500 °C



Jelly roll after 4 s



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- Temperature propagation [°C] in the prismatic cell and the Jelly roll

Conclusions and Outlook

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- A thermo-physical 3D model of a commercial lithium-ion cell was developed and validated.
- Temperature distribution inside a lithium-ion cell during battery stack assembly were simulated.
- Further studies on various stress scenarios representing battery stack assembly at elevated temperatures will be performed.

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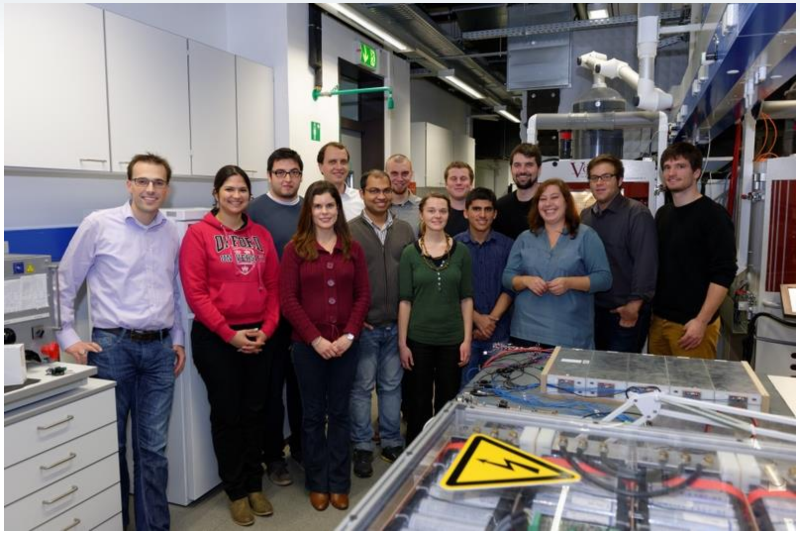

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Thank you for your attention! Questions?

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