Concepts for Compensating Pressure Fluctuations Inside Future Lithium-Ion Battery Cells

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Project: KoDI – Kompensation von Druckschwankungen im Inneren von Batteriezellen

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New Battery Materials

- **New electrode materials (silicon-composite- and lithium-metal-anodes)** and solid-state electrolytes ensure higher volumetric and gravimetric energy density, longevity and ecological compatibility
- **High volumetric changes of the electrode materials** (e.g. 300 – 400% for silicon and theoretically ∞% for lithium metal) during cycling result in high pressure changes, cracks and material degradation
- **Adaption of cell and module housing** is necessary to compensate volumetric and pressure changes

State of the Art Battery Housing

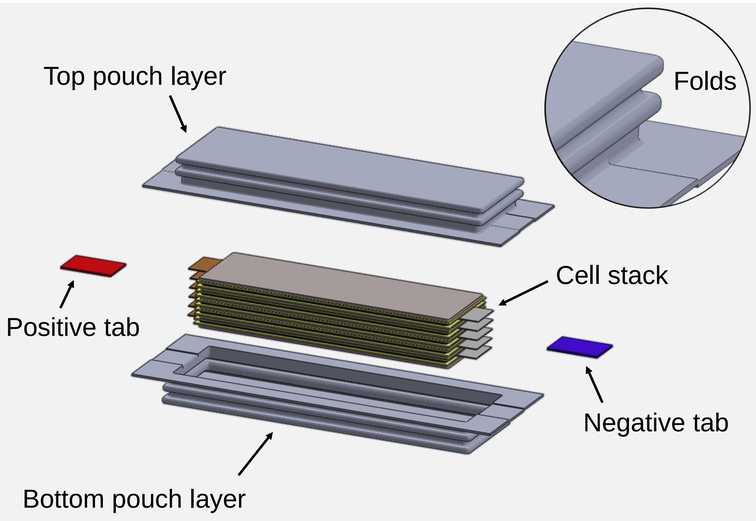
- **Pouch cell housings** are lightweight, offer a high specific capacity and good heat dissipation
- Volumetric change of electrodes during cycling results in direct **volumetric changes of cells causing fractures and leakage**
- Today **cell stacks are spring-loaded** to avoid volumetric changes

Conventional pouch cell

Objectives and Requirements

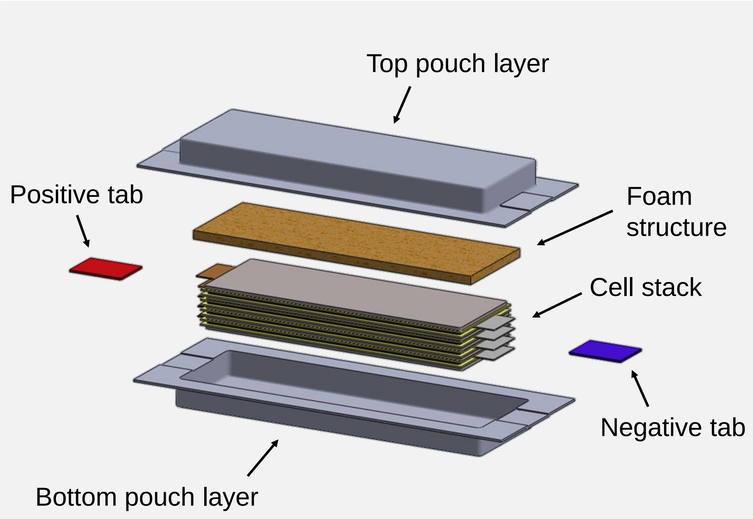
- Development of mechanisms to **compensate volumetric changes on cell level calculated to up to 20%**
- **Distributing an homogeneous outer pressure (0.5 to 25 MPa)** for constant electrode contacting and uniform lithium-ion insertion
- **Maintaining fluid tightness, cycle and temperature stability** of conventional pouch-cells
- **Avoid chemical side reactions** between mechanisms and cell materials

Foldable Pouch Cavity



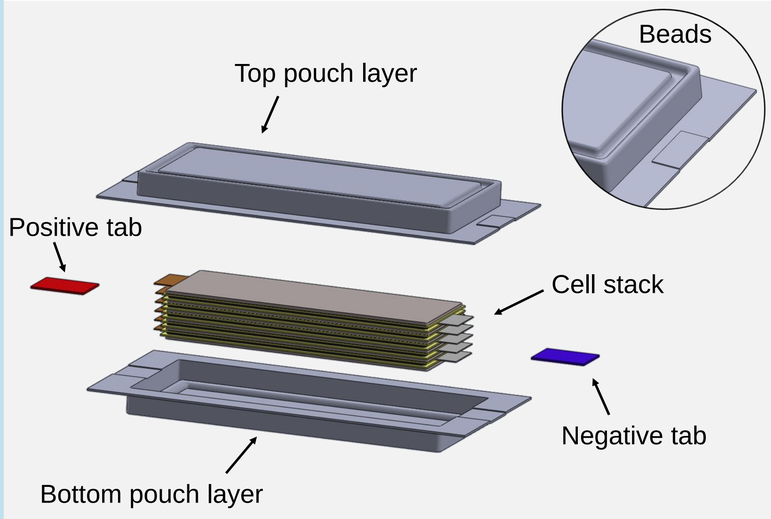
- High weight and volume efficiency
- Requires movable cell positions in cell stacks
- Requires compensation mechanisms on module/ systems level
- Independent of desired stack pressure

Elastic Foam Structure



- Low weight and volume efficiency
- Allows fixed cell positions in cell stacks
- Does not necessarily require compensation mechanisms on module/ systems level
- Dependent on desired stack pressure

Stiffening Pouch Cavity



- High weight and average volume efficiency
- Allows fixed cell positions in cell stacks
- Requires compensation mechanisms on module/ systems level
- Independent of desired stack pressure

Next Steps

- **Detailed development of concepts** regarding manufacturability (e.g. formability of pouch foil and foamability of suitable foam materials)
- Development of **systems to simulate volumetric changes** in pouch housings to reduce safety hazards occurring when electrode materials are used
- **Experimental evaluation of concept-functionality** using this simulation systems
- Design of **compensation mechanisms on module level** outside the cell

First deep drawings of stiffened pouch cavities

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