

OrtOptZelle – Position dependent compression of pouch cells for lifetime expansion

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State-of-the-Art

- External pressure on lithium pouch cells can decrease capacity fade [1]
 - Initially compressed cells in electric car modules [2]
 - Pressure distribution and passive heat dissipation improved by usage of cushioning foams equipped with PCMs [3]
- Mechanical failure due to geometrical inhomogeneities causes aging of cylindrical cells [4-6]
- Inhomogeneities due to dilation [7]
- Volume changes of anode and cathode while cycling lead to reversible and irreversible thickness growth [8,9]
- Local pressure can change current distribution in the battery cell [10]



Max. pressure distribution on compressed pouch cell surface without cushioning foam (0.05 - 2 MPa)

Aging phenomena:

- Inhomogeneities in geometry e.g. electrode overhang can cause different current distributions in the cell
 - Leads to mechanical stress by gradients in temperature, volume change
 - Locally distributed aging indicators, e.g. lithium plating and electrode delamination

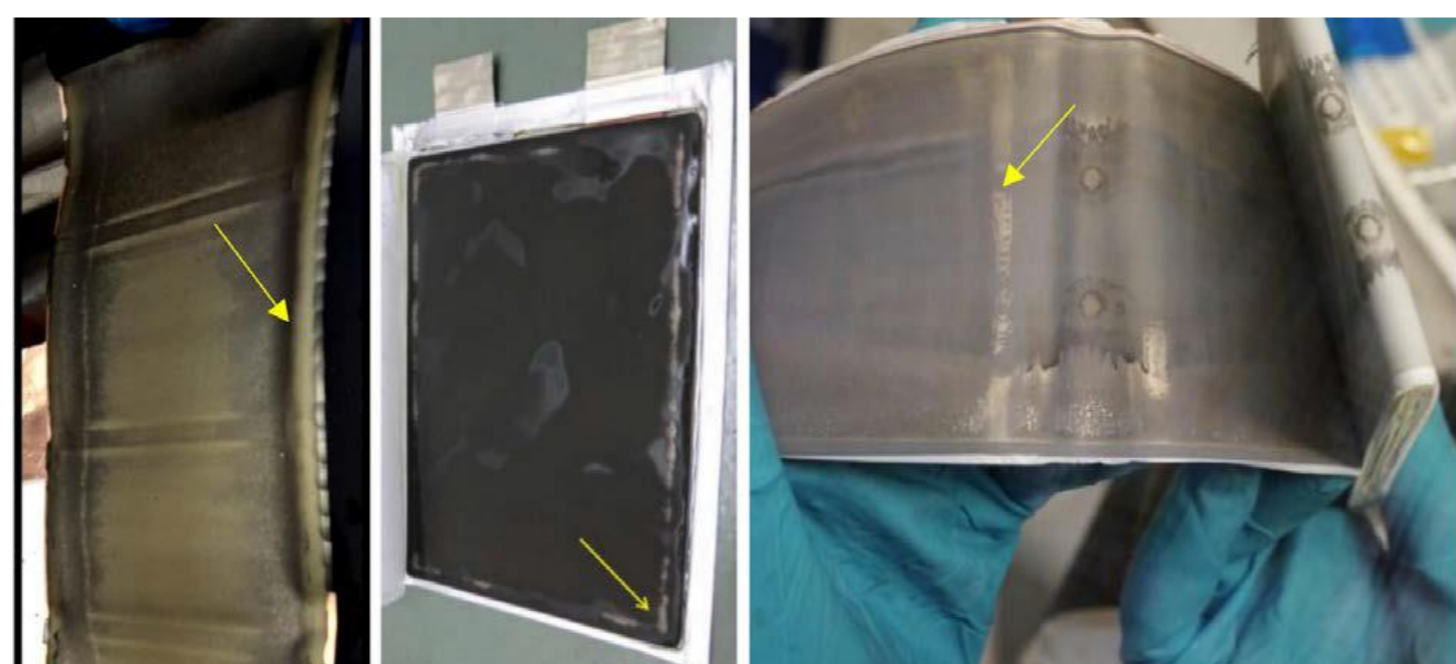


Image taken from [7]: Left to right; Inhomogeneous lithium plating on graphite electrodes in 18650-cell, pouch cell and prismatic hard-case cell

Analyzing methods:

- Capacity fade and resistance growth (EIS)
 - Cyclic and calendric aging tests
- X-ray computed tomography (CT)
- Post-Mortem optical and SEM studies

Sources:

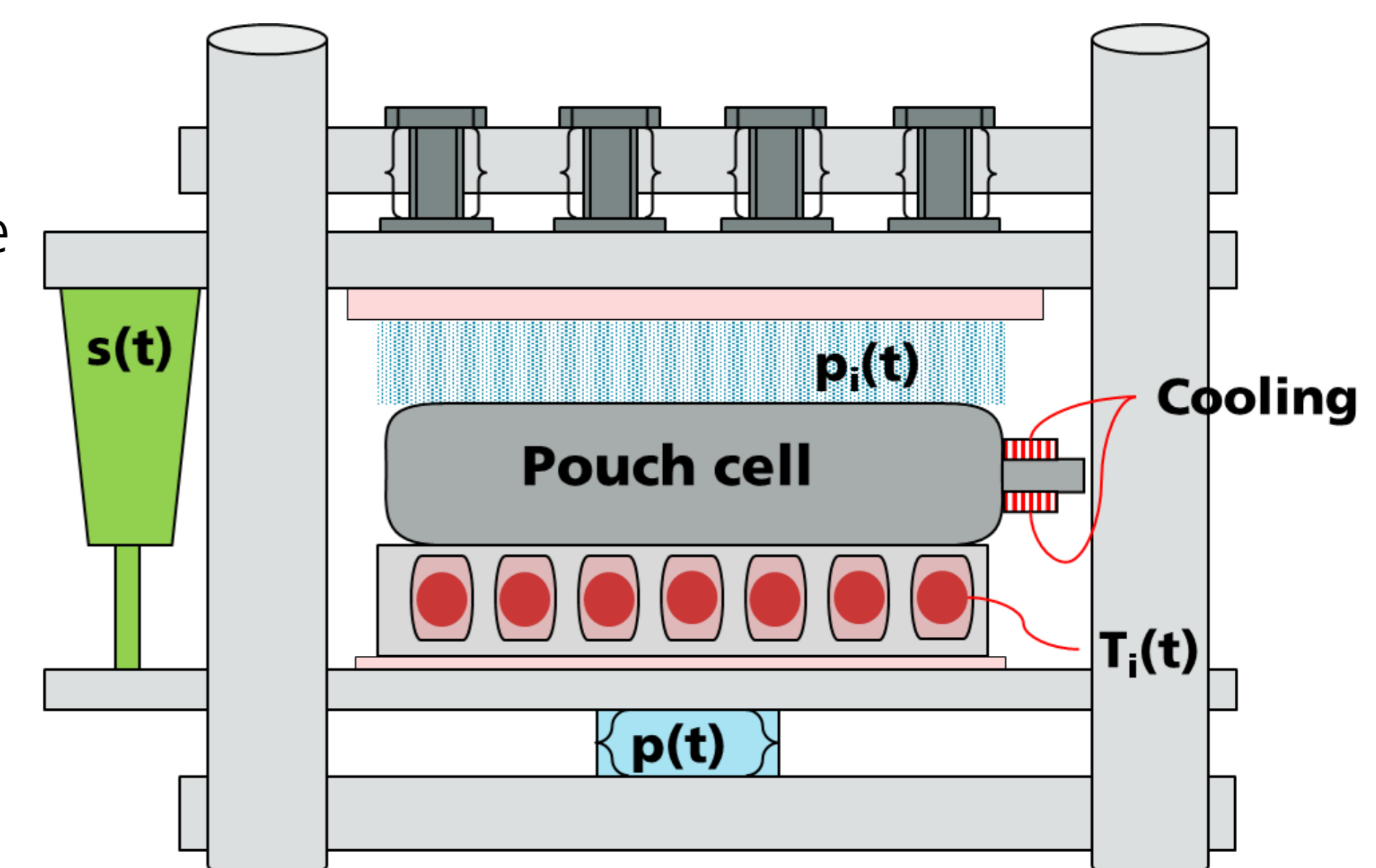
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Main project goals

- Prolong the lifetime by applying a total or partial compression on the battery cell. The compression has well-defined locally-resolved pressures, limiting the expansion during charging/discharging.
- Exact investigation of locally distributed aging processes with further suppression due to defined compression.
- Precise measurements of the areal distribution of volume changes, temperature gradients and current density on the battery cell during charging/discharging

Testbench model

- Modular testbench setup
- Measurement by controlled pressure, controlled distance and/or controlled temperature
- Integration of sensors with high resolution
- Strong mechanical stability for eliminating systematic errors

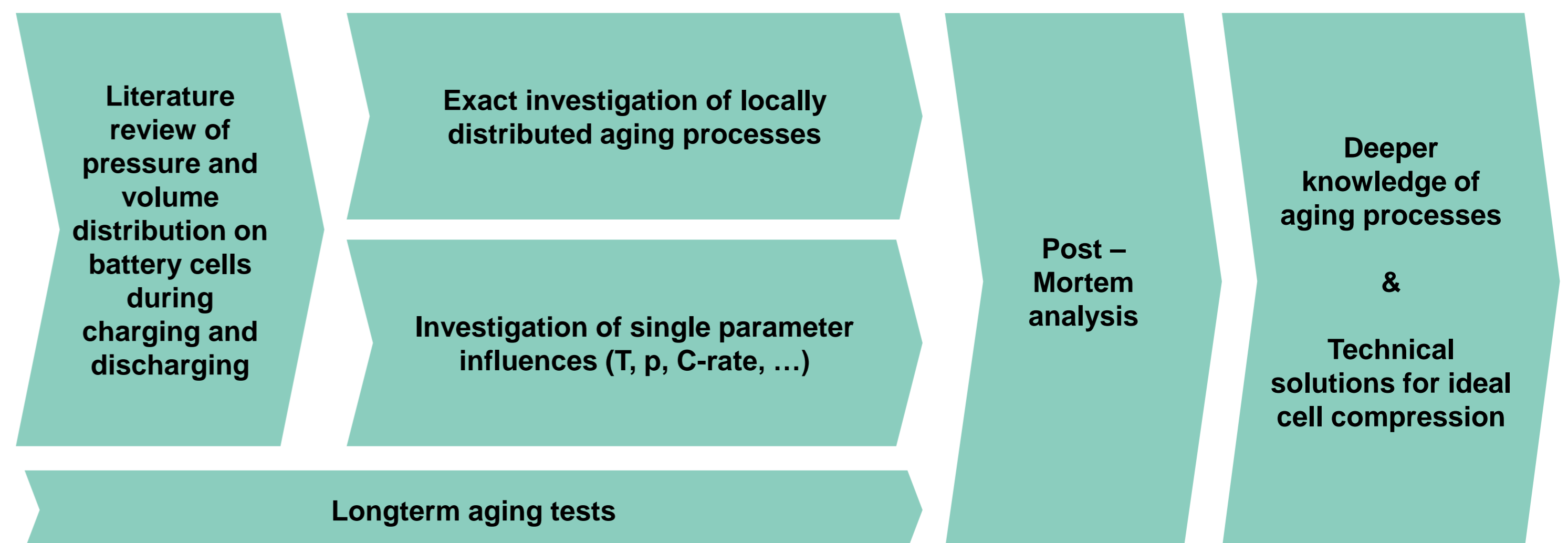


Model of first testbench plans; Inspired by Deich et. al [10]

Measurement strategy

Two-path approach:

- Zooming principle: Localizing aging and separate influences
- Direct proving of theory: chemically and physically based technical solution for empirical studies



Aimed results

- Finding an ideal local pressure distribution for pouch cells in a module
- Gain of knowledge of aging prevention through technical solutions
- Expanding the cell lifetime of the battery cells by 50%

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