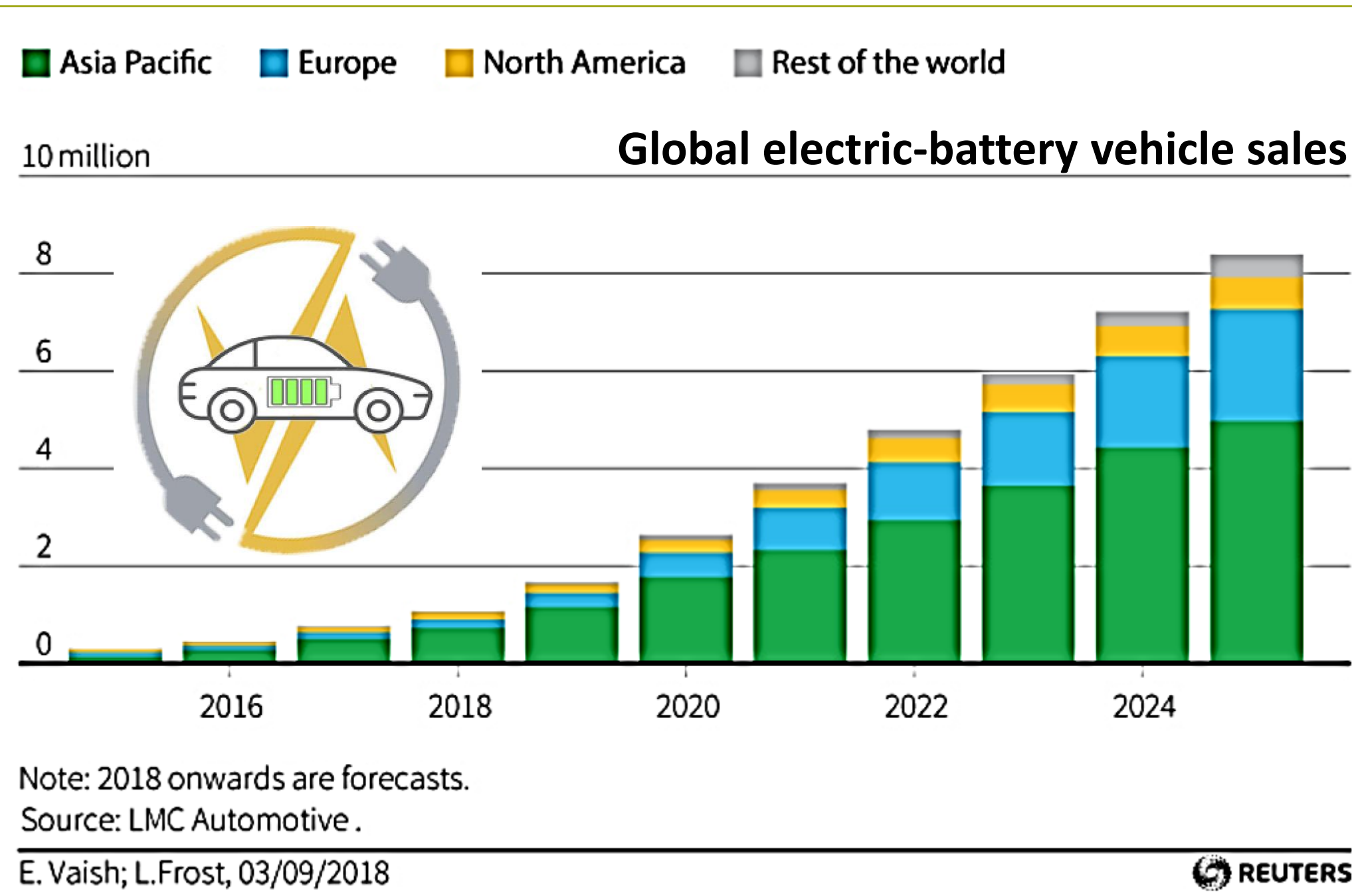


Analysis of the influence of electrochemical aging effects on the mechanical properties of lithium ion batteries

Georgi Kovachev, Gregor Gstrein, Wolfgang Sinz, Christian Ellersdorfer, Vehicle Safety Institute, Graz University of Technology, 8010 Graz, Austria



Motivation



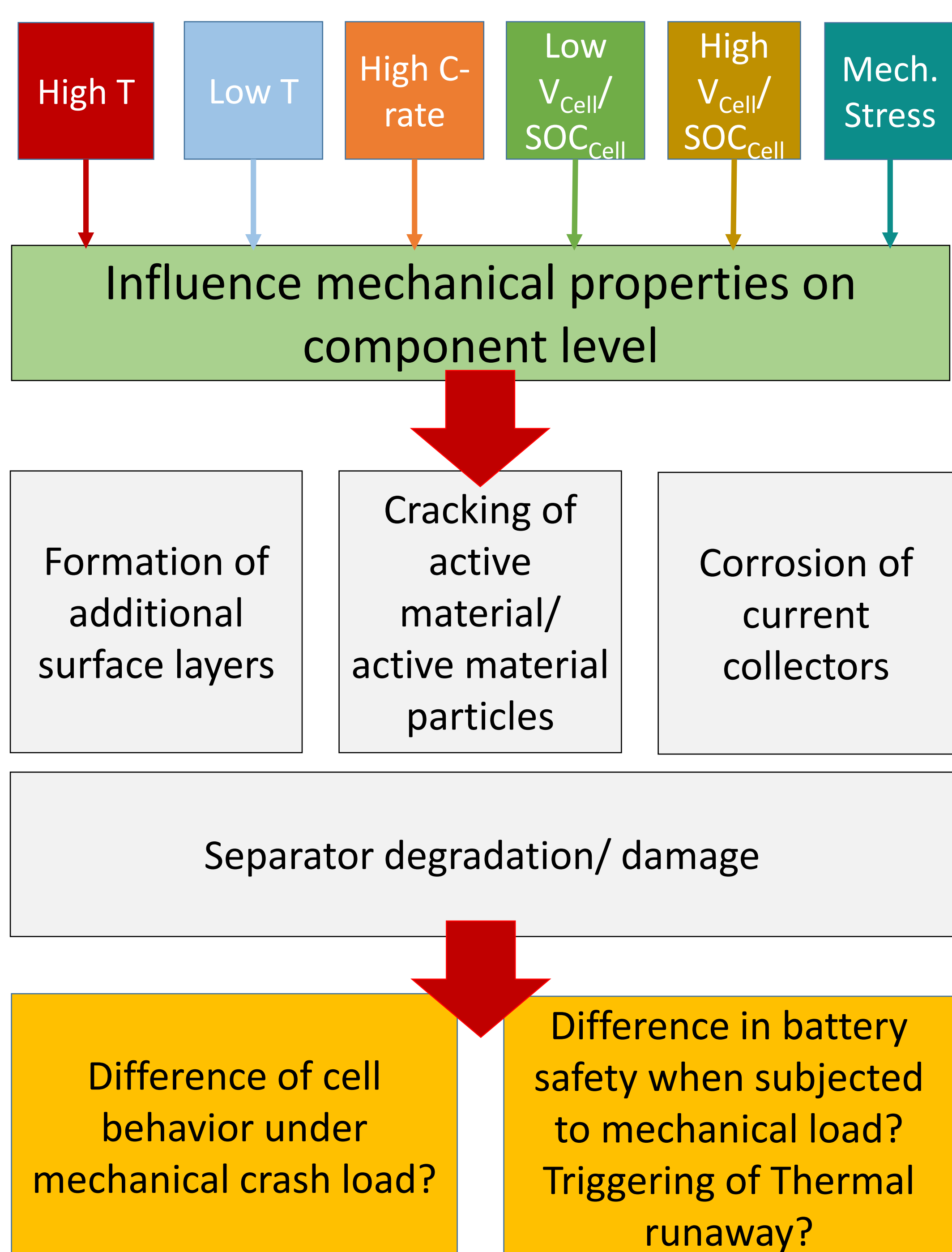
- Exponential growth of electric vehicle usage
- Batteries of EVs exchanged based on capacity loss limit
- Battery safety of aged batteries still not known

Research questions

- Does **electrochemical ageing** affect the **mechanical properties** of Lithium Ion Batteries?
- Do battery **degradation mechanisms** have an influence on the **mechanical behavior** of the **battery components**?
- Which are the most **critical degradation mechanisms** affecting **battery life** and **mechanical characteristics**?
- Are **aged** Lithium Ion Batteries **more critical**?

Battery degradation mechanisms

- Battery aging based on real driving cycles not considered:
 - Triggering multiple degradation mechanisms simultaneously
 - No information of the internal processes happening can be gathered



Method

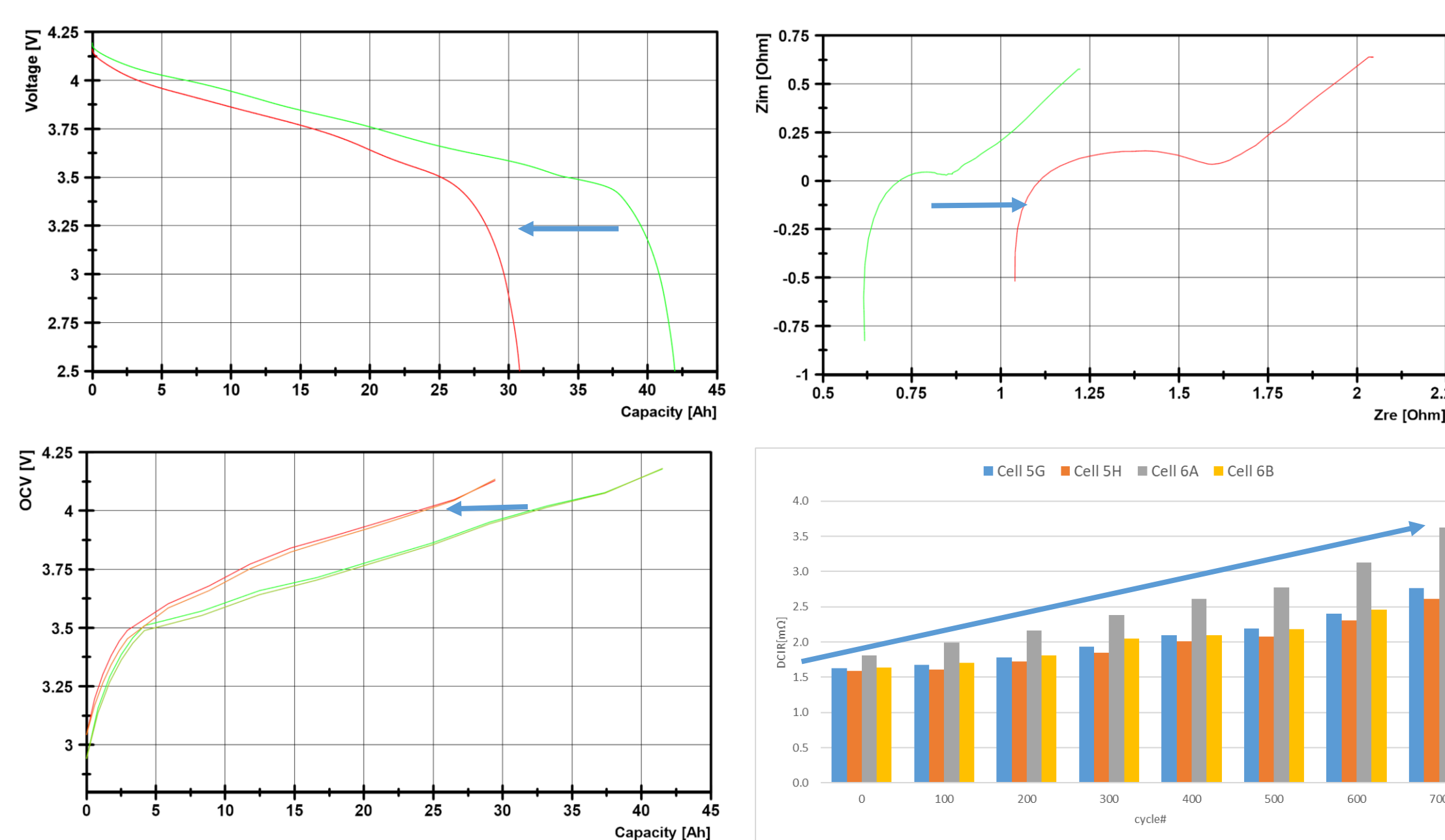
Artificial ageing of cells to cause specific degradation mechanism

Assessment of cells (electrical, non-destructive, post-mortem)

Abuse Testing to analyse mech. properties and TR-risk

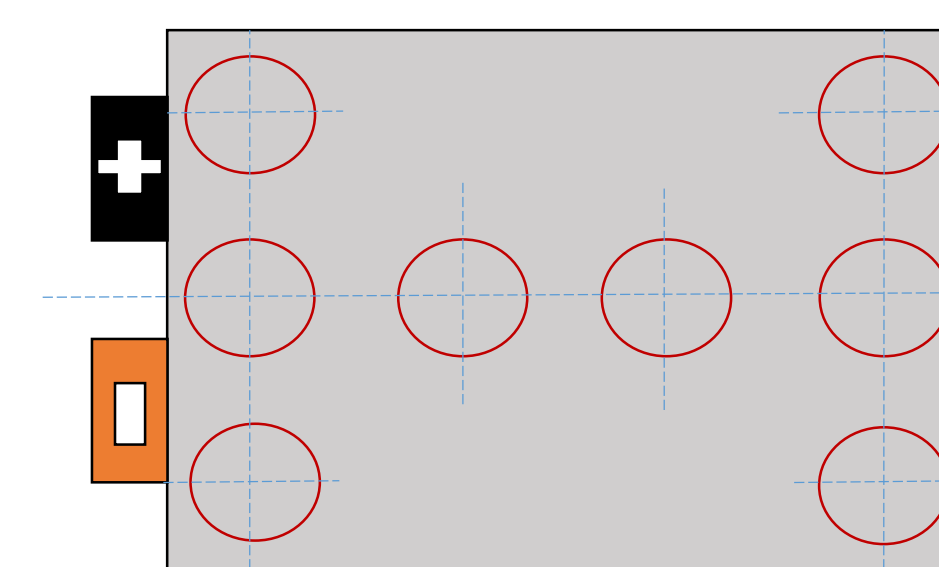
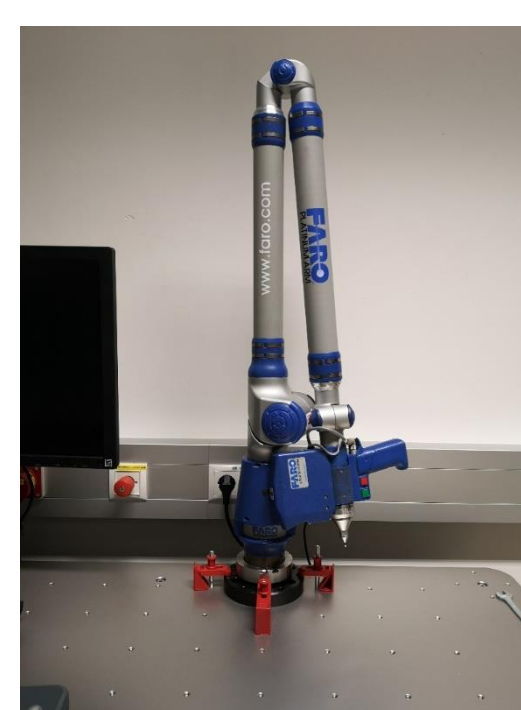
Assessment of cells

Electrical characterization



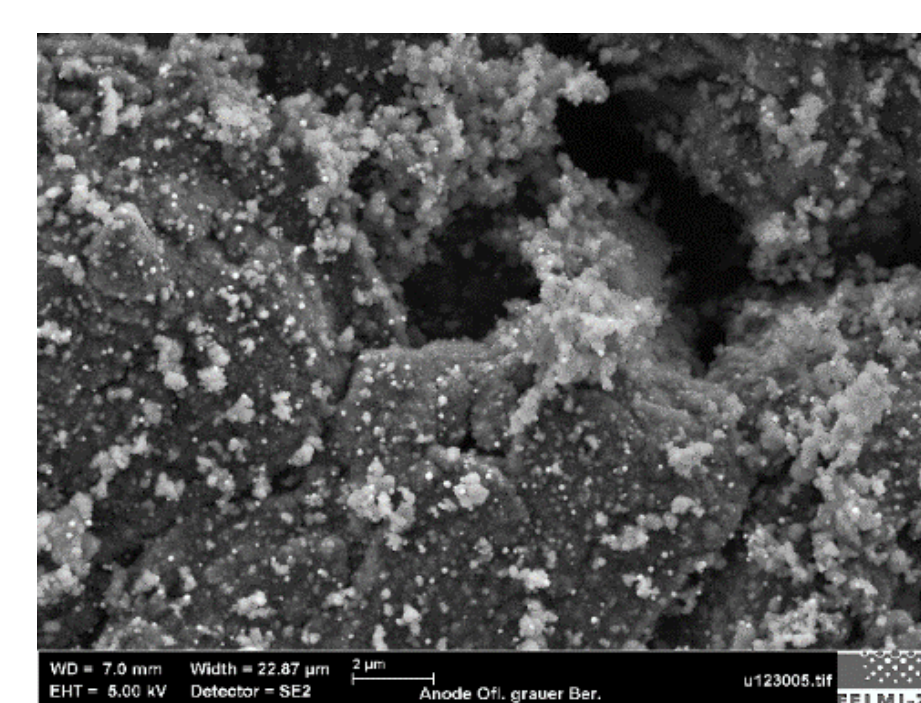
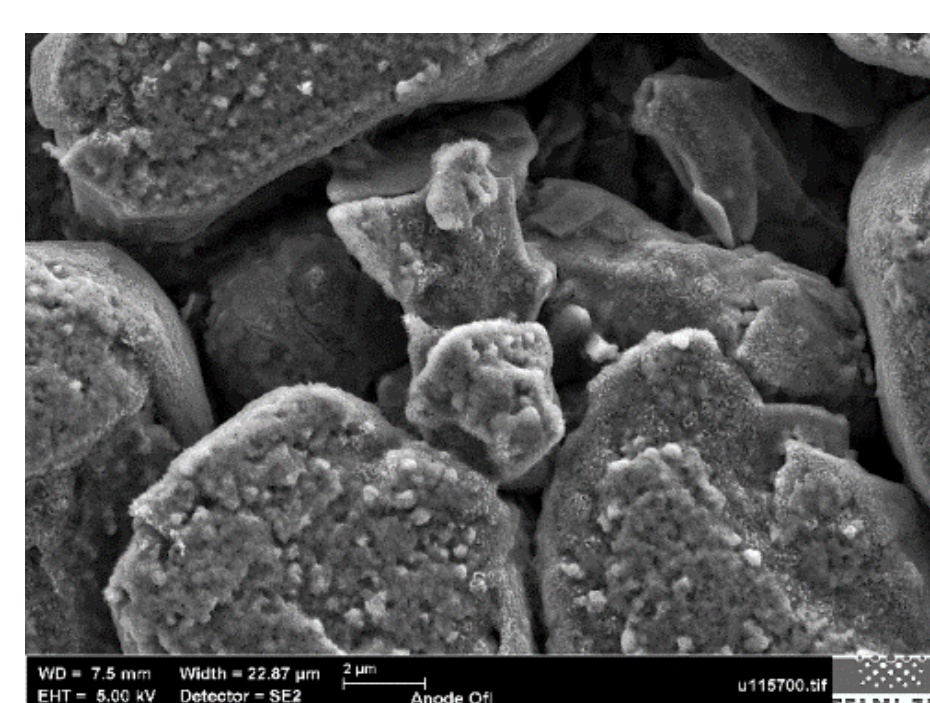
- Electrical characterization done every 100 cycles
- Discharge curve and discharge capacity
- Impedance based on EIS measurements
- Open circuit voltage
- Internal resistance

Thickness measurement



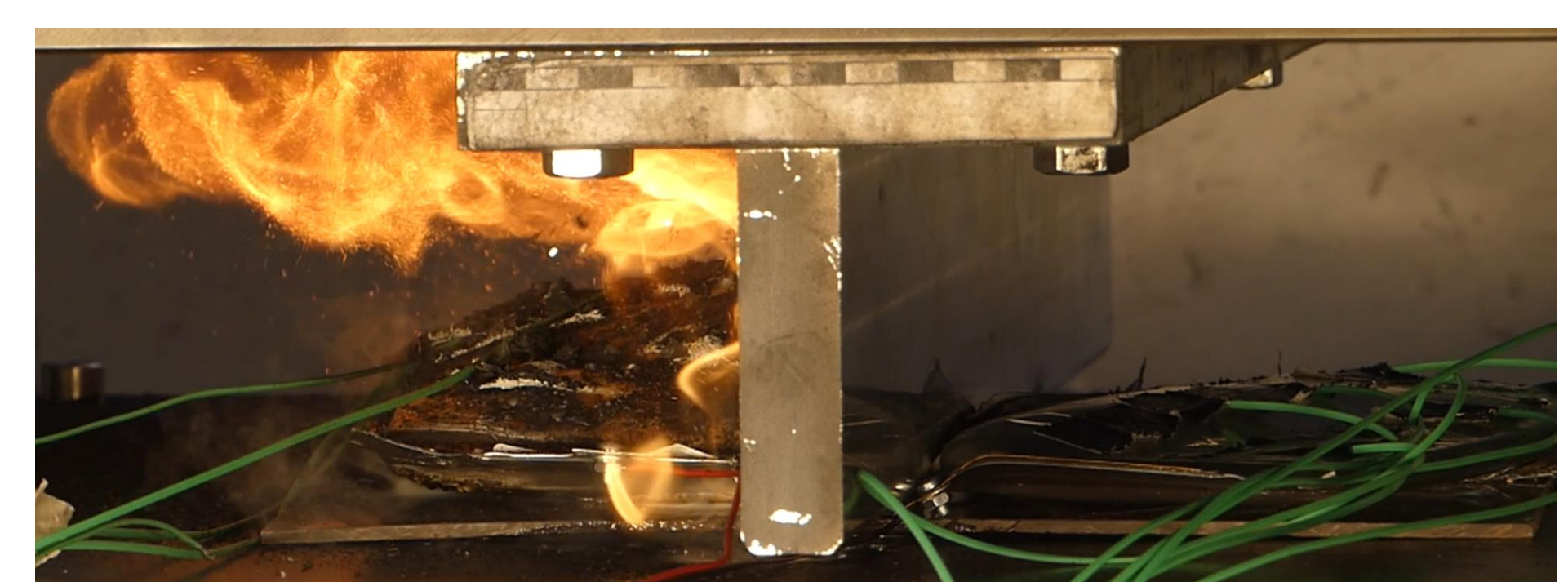
- Thickness measurement before and after ageing
- Determination of irreversible swelling due to battery degradation

Post-mortem analysis



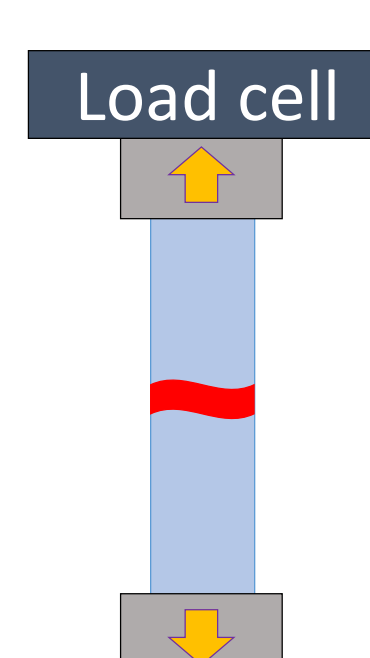
- Visualization of aging effects, occurred during battery cycling

Mechanical testing



- Quasistatic mechanical tests conducted to evaluate battery behavior
- Same test configuration and testing conditions for fresh/ aged cells
- Evaluation influence on cell level

Component testing



- Assess changes to battery components in different loading configurations
- Loading configurations chosen based on expected degradation mechanisms
- Does component degradation explain any changed behavior on cell level?

