SUCCESS STORY

FFG Promoting Innovation.

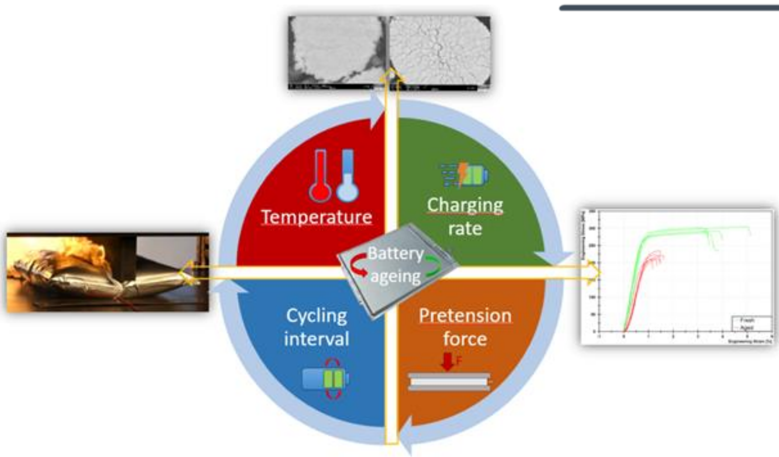
SafeBattery
Safe Lithium-Based Traction Batteries

Sichere Lithiumbasierte Traktionsbatterie

Programme: COMET – Competence Centers for Excellent Technologies

Programme line: COMET-Project

Type of project: P3 INPUT, 04/2017 – 03/2021 multi-firm



MECHANICAL AND SAFETY BEHAVIOR OF CYCLE AGED LI-ION BATTERY CELLS

CYCLE AGEING LEADS TO DEGRADATION OF THE INTERNAL STRUCTURE OF LI-ION BATTERIES, WHICH IS A PREREQUISITE FOR AN EARLIER MECHANICAL FAILURE UNDER MECHANICAL LOAD

Battery degradation during operation

During their lifetime, lithium-ion batteries in electric vehicles experience numerous charging/ discharging cycles. These are accompanied by a constant degradation of the internal structure of the battery, leading to poor battery performance and a reduction of its initial capacity. The occurrence and evolution of specific degradation effects inside the battery depend thoroughly on the operation conditions the battery is subjected to.

Car accidents can result in a mechanical load acting on the traction battery of any electric vehicle involved. This raises the question what would the mechanical response of the battery cells be compared to fresh ones, if they already had experienced a high amount of charging/ discharging cycles? What influence do the battery degradation effects have on the mechanical and safety behavior of the cells in case of crash loads? For this reason the research project **SafeBattery** is targeting to scientifically investigate the electric and mechanical behavior of lithium-based cells after a certain cycle life. Usually in norms and regulations such investigations are conducted on fresh batteries and there is little information on the behavior of aged cells.

Analysis of the behavior and internal structure of aged batteries

Together with industrial partners a cycling program was developed, aiming to produce known degradation effects inside the investigated battery

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cells. Electrical parameters such as battery capacity, internal resistance and impedance were tracked for the entire duration of the ageing procedures and were used for characterization of any electrical changes to the battery. Cycle aged batteries were disassembled in order to visualize and evaluate any structural changes to the internal components.

Lateral quasi-static indentation test was used to apply a surface load on fully charged fresh and cycle-aged cells. Comparison of the mechanical and safety response of the cells was conducted based on the measured mechanical resistance and battery deformation. Cell reactivity and thermal runaway behavior were evaluated based on video data, recorded during testing.

Impact and effects

The tested aged battery cells were able to withstand higher mechanical loads compared to their fresh equivalent and have also shown an overall softer mechanical response (**Fehler! Verweisquelle konnte nicht gefunden werden.**). This was accounted mainly to the structural degradation of the internal components. The growth of a thicker passivating layer on the anode surface was the main reason for an irreversible thickness increase of aged cells.

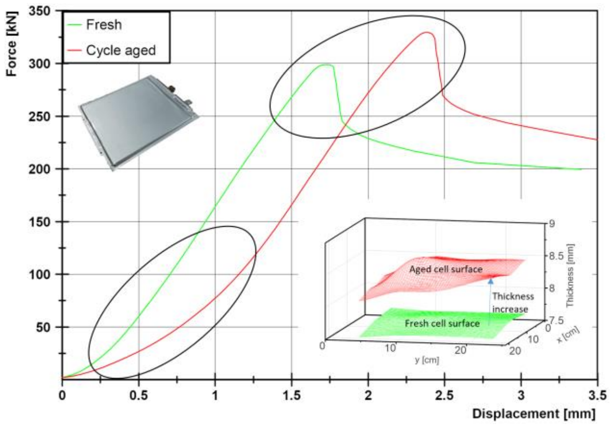

Figure 1: Changes in the mechanical behavior of aged cells and thickness increase after a certain cycle number © SafeBattery

For the used loading configuration a decrease in the hazard risk of aged batteries was identified. Additional research is being conducted in order to find out if this is the case for dynamic loads acting on the battery.

The generated knowledge serves as a first step in investigation of the mechanical response of aged cells and can be used for the creation of more optimal battery designs for electric vehicles.

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- Daimler, GER
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- Kreisel Electric, AUT
- Bosch, GER
- SFL engineering, AUT
- TU-Graz (ICTM/VSI), AUT
- VIF, AUT

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