EES @ BAM

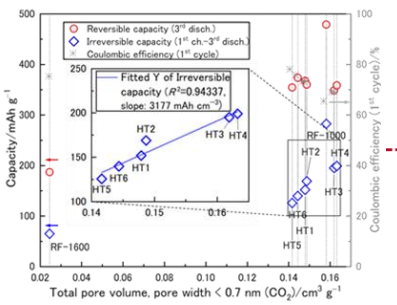
Hazard-based classification of lithium batteries and cells

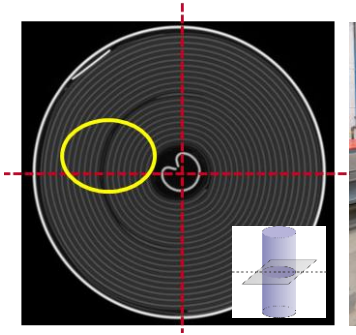
Short information on the UN TDG IWG Lithium Batteries

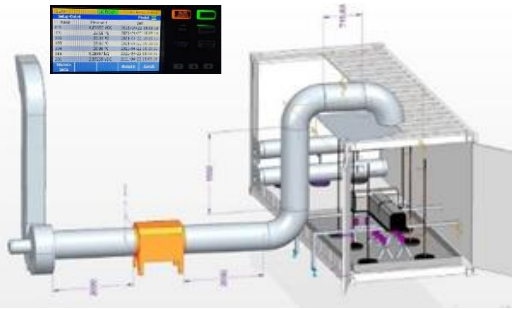
2 concepts from UN TDG of potential interest for WP.15 IWG-EV

A. Schmidt, BAM

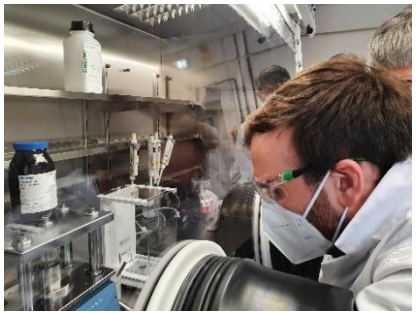
EES@BAM:
From Lab scale to Application scale

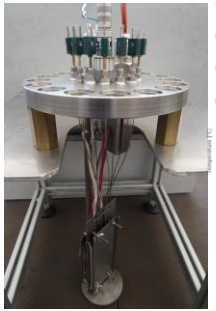


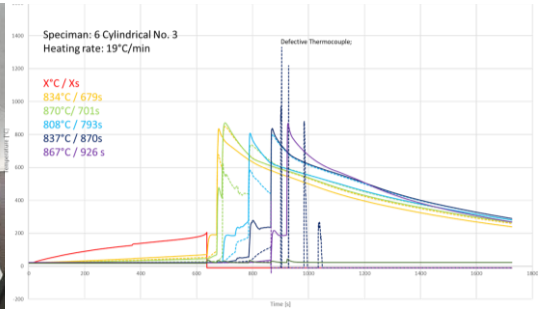




Material Cell Module/Pack Application







BAM Sites

Materiallaboratory

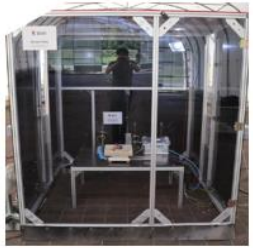


Analytics and characterization

Cell test lab



large teststands TTS



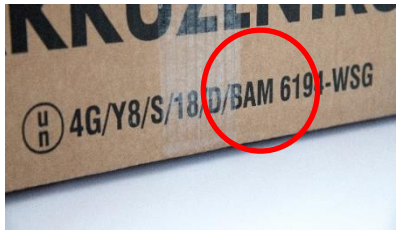

Tasks of BAM in the field of Lithium batteries

BAM is the competent authority in Germany (according to § 8 GGVSEB) for:

- Type examination and approval of dangerous goods packaging
- Permits for transportation of untested prototypes of lithium batteries, unpacked
- Specifications for the transport of critical defective or damaged batteries

BAM participates in:

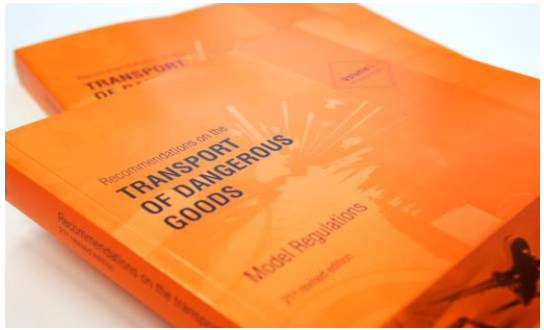
- UN TDG subcommittee (with German Ministry of Transport BMVI)
- UN working group on the classification of Li-batteries according to their hazards
- UN working group on „repair“
- WP.15 working group Electronic Vehicles



Concept 1: Critically defective Li-Batteries

„critically-" defektive Lithium batteries

- definition in ADR SP 376 (strong previous damage, tend to dangerous reaction under transport conditions)
- since 2019: Packing Instruction P911/LP906



UN model regulations

Burning notebook, BAM TTS

Specifications for the transport of critically defective Lithium batteries

Test requirements:

Packing Group I

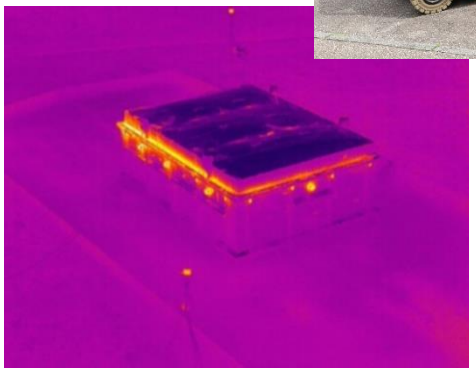
- Drop test 1,80m (with dummy) weakest position of the bottom
- Stacking test,
- LP: bottom lift test, top lift test

Successful Fire Test

- Real Battery
- Initiation method may be chosen
- Temperature of outside surfaces must be below 100°C (shortly below 200°C)
- Packaging must stay intact

BAM TTS small drop tower

Source:
Fa. LogBATT GmbH



Challenge: Fire test

- Test setup
- Safety measures !
- BAM has described test procedure

BAM has extensive experience from numerous submitted test reports and own tests

The results strongly depend on the test battery !!!
⇒ Chemistry and geometry

Test results only transferable to similar batteries !

Test for qualification of a box for transport of critically defective LiBs, BAM TTS

Concept 2: UN TDG IWG LIBs current results

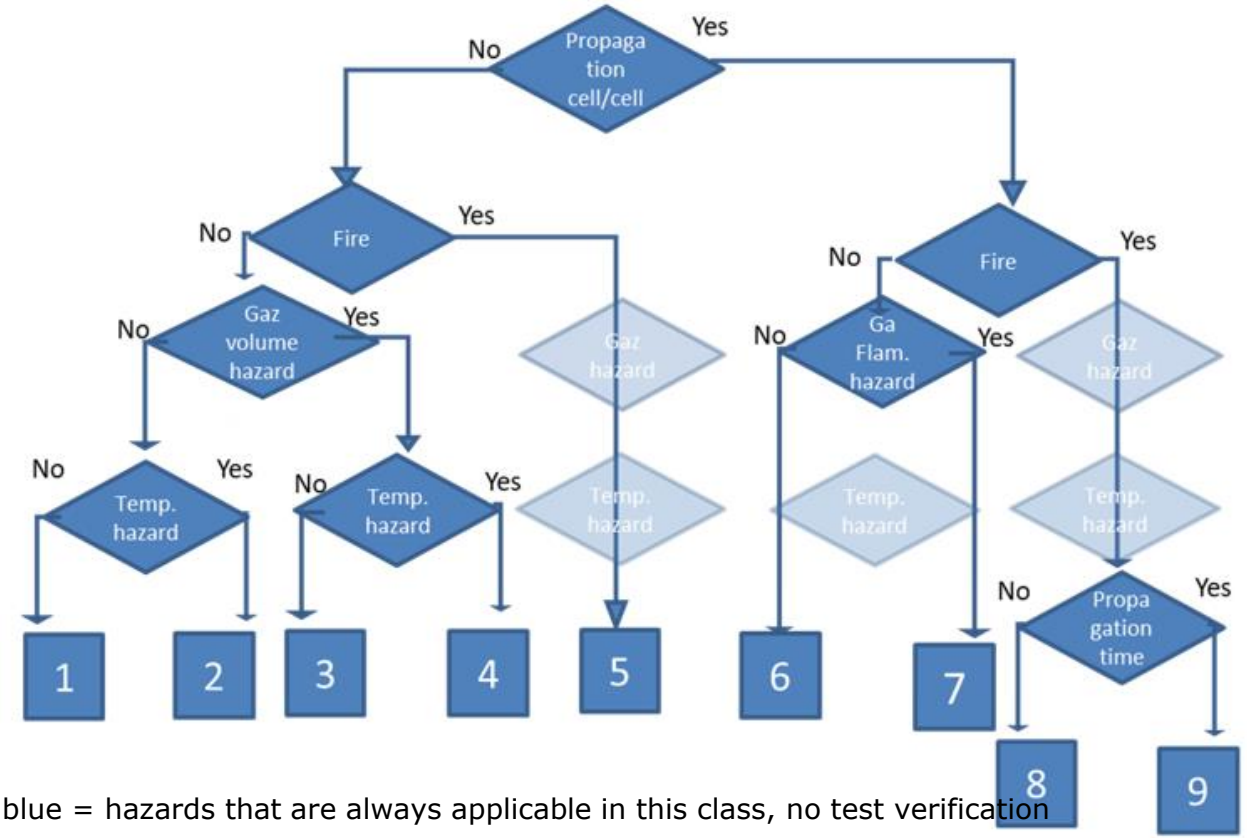
Achievements of the IWG so far:

- classification Model has been developed
  - 9 categories
  - decision diagram tree
  - test procedures and criteria to assess in which category a cell/battery belongs.

The UN existing classification of lithium batteries will still apply (UN 3090 and UN 3480) and will still be based on 38.3.

Classification model is based on the testing performed by the UN IWG members (9 labs, BAM as one of them)

UN TDG IWG LIBs
Classification: Decision tree



light blue = hazards that are always applicable in this class, no test verification

UN TDG
Informal Working Group (IWG) LIBs

Test scheme to classify cells / batteries according to their hazards
Identified hazards are:

- capability for a thermal run-away to propagate from cell to cell.
- capability to generate fire.
- capability to generate significant quantities of gas. The gas composition may be toxic and/or flammable. Classification to be based on the quantity of gas.
- capability to produce high temperature.

The classification tree => in the model regulation, tests for the classification decisions of the diagram=> in the UN Manual of Test and Criteria

UN TDG
Informal Working Group (IWG) LIBs

In case no test is performed, the cells will be considered as category 9.

The following default values are assumed: (for li-ion cells)

- the propagation occurs from cell to cell with a speed of [100 mm/8s]
- the gas emissions can contain UP TO 35%vol hydrogen, 30%vol CO and 30%vol organic carbonates (EC/DEC) and 4% HF with a volume of 1,5 l/Wh of cell.
- the fire risk is applicable [and maximum temperature related to fire]

UN TDG
Informal Working Group (IWG) LIBs

Tests to classify batteries according to their hazards

3 Tests: **test protocolls under development**, discussions almost completed

- TR initiation by heating (up to 350°C),
  method described in detail
- Propagation test:
  4 cells in a row, first cell is heated at a rate of [15+-10] °C per minute
  - No propagation, or
  - propagation (Propagation rate below [1000] mm per min), or
  - rapid propagation (above [1000] mm per min)

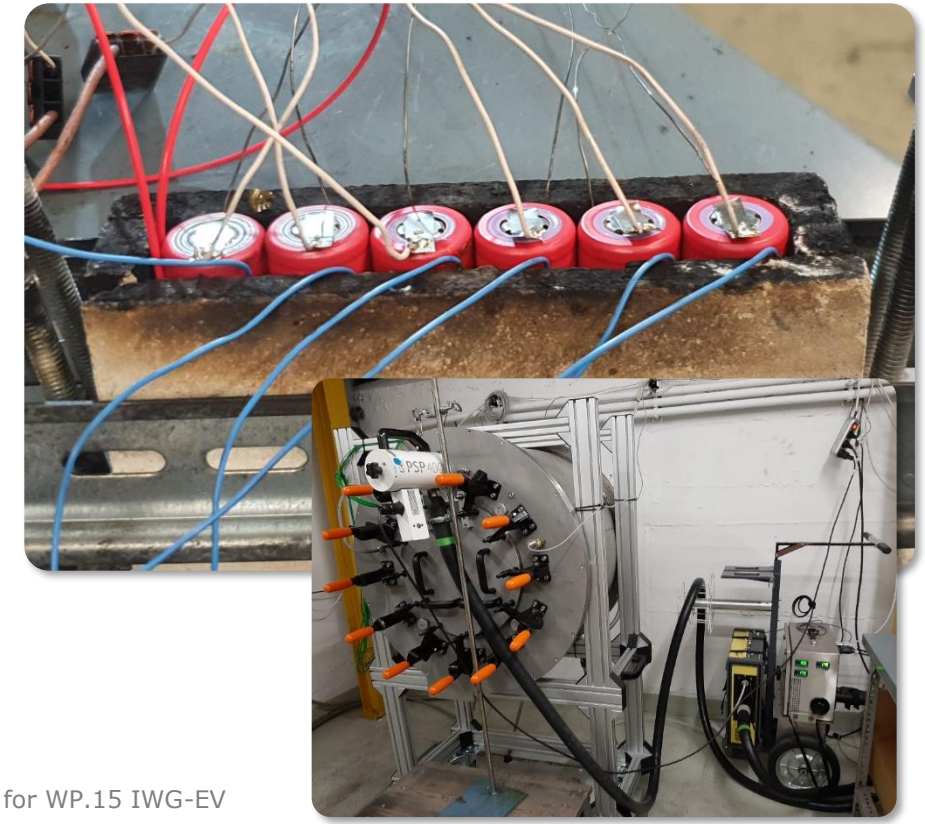
Tests for Temp hazard and flammability

Tests transferred for batteries

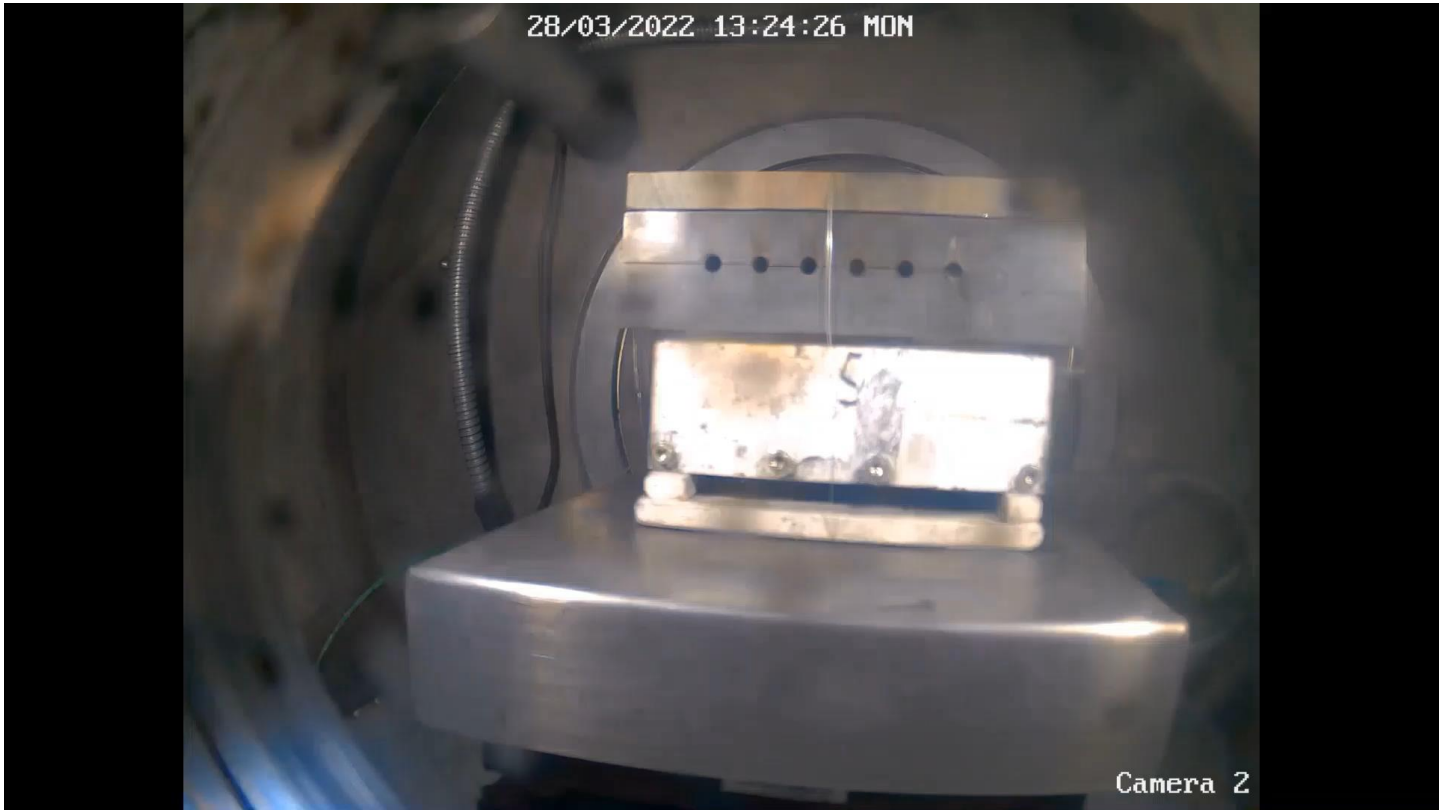
Tests at 100%SOC, at lower SOC also possible if transported as such !

Cell-propagation Test setup of UN IWG

- **6 (4) cells in a row**
  - LCO
  - 2,4 Ah
  - 18650
  - 5 $Kmin^{-1}$
  - SOC = 100%



Zell-Propagations Test im Rahmen der UN IWG

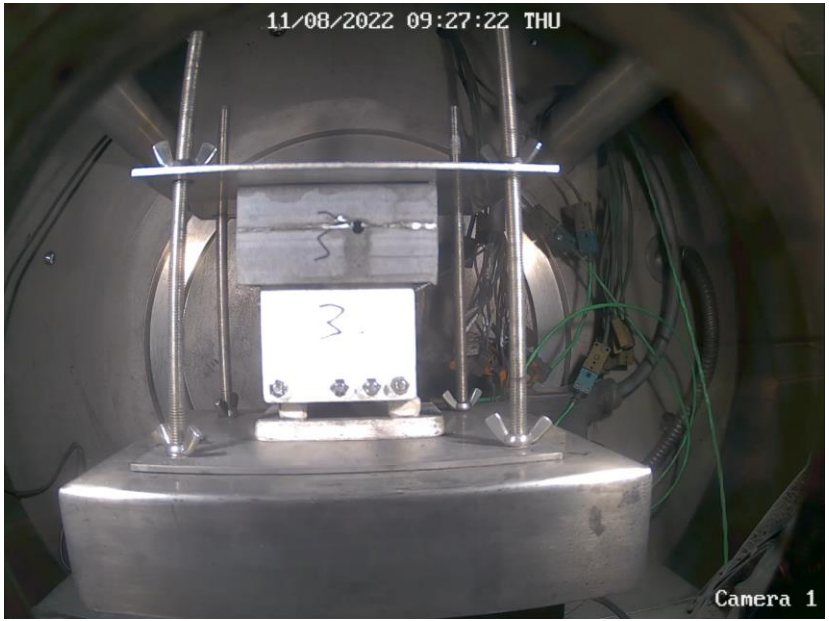


Thermal Runaway (TR) of Li-Ion Cells

Comparison of atmospheric conditions

air

nitrogen



Thermal Runaway of Li-Ion Cells

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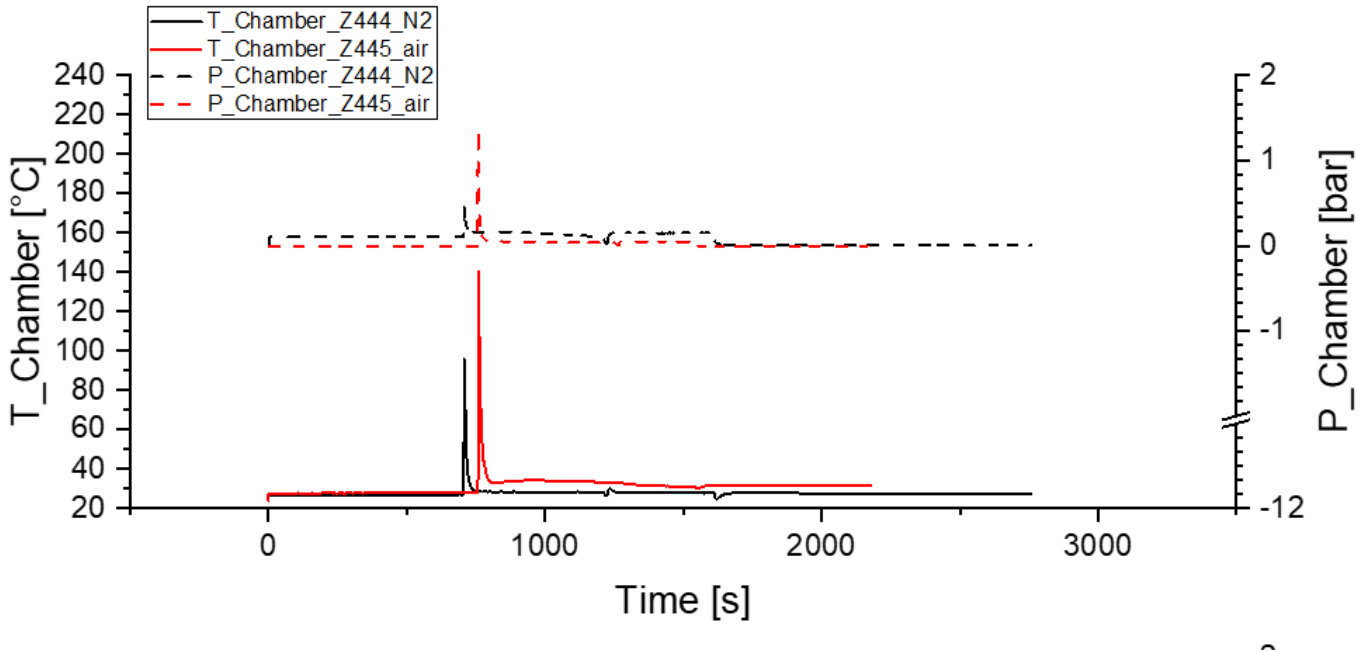
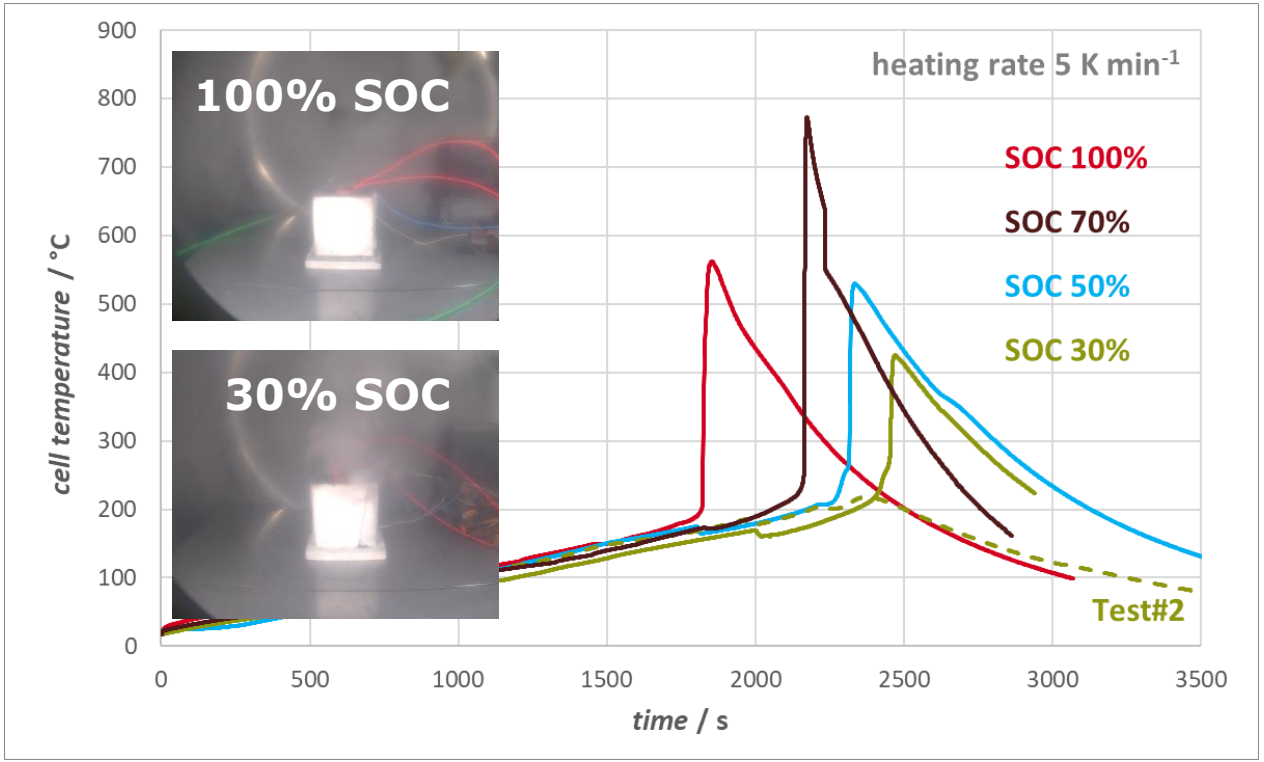


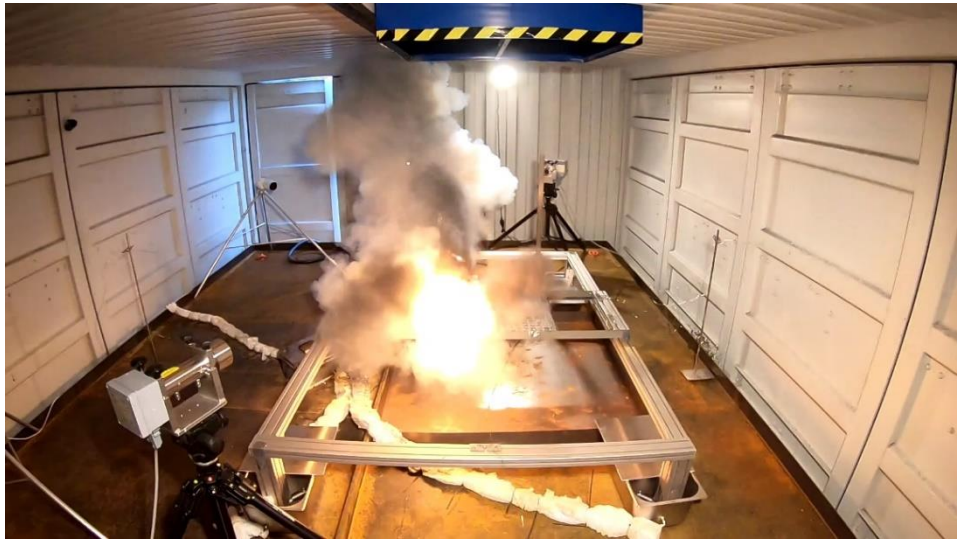
Influence of SOC on TR of a cell

- **Parameters**
  - LCO
  - 2,4 Ah
  - 18650
  - 5 Kmin^{-1}
  - Different SOC



Next steps

- Second test campaign (battery level) is ongoing at UN



#2ndlife Energiespeicher: Thermisches Durchgehen eines Batteriemoduls im Projekt SEE-2L (2/3) – YouTube

#2ndlife Energiespeicher: Thermisches Durchgehen eines Batteriemoduls im Projekt SEE-2L (3/3) - YouTube

Thanks!

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