

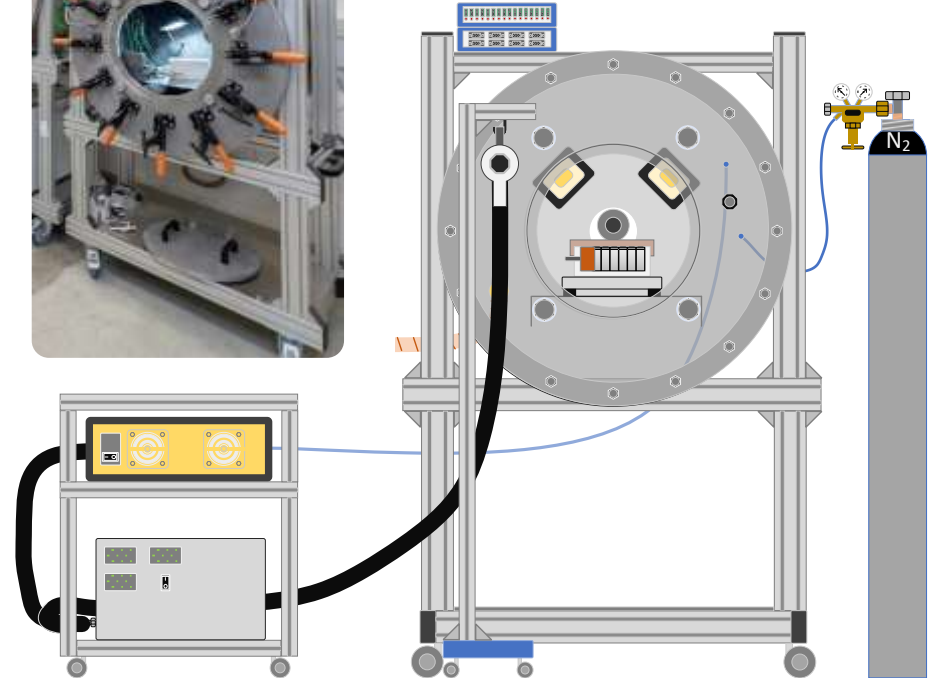
UN-IWG-Meeting, Geneva, December 2023

# **UN-IWG-LIBs Work Report BAM**

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3.1 Safety of Dangerous Goods Packagings and Batteries  
Bundesanstalt für Materialforschung und -prüfung (BAM)

- **4 test chambers**
- $V_{\text{chamber}} = 247 \text{ L}$
- **equipped with:**
  - pressure sensor
  - up to 12 thermocouples
  - up to 8 voltage/current channels
  - optional with online-FTIR
- **various operation modes**
  - closed
  - open (vs. atmosph. pressure)
  - Air/N<sub>2</sub>-flux (under develop.)
- **various abuse types**
  - thermal
  - mechanical (nail penetration, crush)
  - electrical (short circuit, overcharge,...)



# Overview of overall conducted tests at BAM according to UN-Protocol → (small) cell level

cathode type cell format nominal capacity*		LCO pouch 4.8 Ah	NMC 18650 2.0 Ah	NMC 18650 2.4 Ah	NMC 18650 2.6 Ah	NMC 18650 2.9 Ah	NMC 26650 5.0 Ah	NMC 21700 5.0 Ah	NCA 18650 2.6 Ah	NCA 21700 4.8 Ah	LFP 18650 1.1 Ah	LFP 18650 1.6 Ah	LFP 26650 3.3 Ah
<b>single cell tests</b>													
atmosphere	SOC	number of valid tests											
air	30%	2	2	2	2	2	2	2	2	2	2	2	2
	70%	2	1	2	2	2	2	2	2	1	2	2	2
	100%	2	4	4	3	4	2	2	2	2	4	3	4
N <sub>2</sub>	0%										1	1	
	20%										2	2	
	30%	2	2	2	2	3	2	2	2	1	3	3	2
	100%	2	2	2	2	2	2	2	2	2	2	2	3
												<b>sum of single cell tests</b>	<b>137</b>
<b>propagation tests</b>													
atmosphere	SOC	number of valid tests (grey --> not analyzed yet)											
air	30%	2		2	2	2	1		2	2			
	50%							1		2			
	70%	2	2	2	2	2	2		2	2	1	1	1
	100%	2	2	2	2	2	2	2	2	1	2	1	1
												<b>sum of propagation tests</b>	<b>56</b>
												<b>sum of total tests</b>	<b>193</b>

\*according to data sheet

**„UN-IWG-cells“**

**LFP cells  
discussed  
in detail  
in Seoul**

# Overview of overall conducted tests at BAM according to UN-Protocol → (small) cell level

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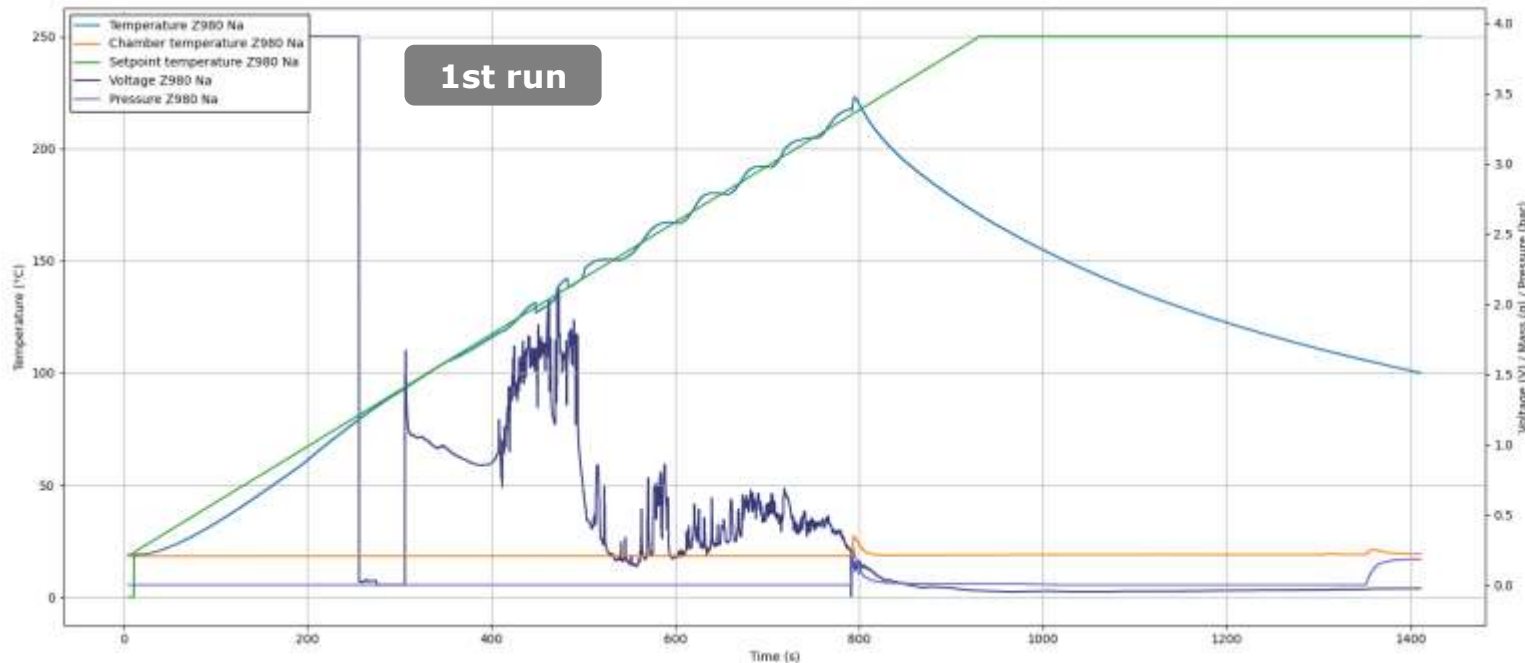
## Additional information:

- for not yet analyzed tests, validity still needs to be evaluated
- invalid tests so far: approx. 20-30
- all single cell tests with additional analysis of emitted gases (FTIR)
- in course of testing, max. temperature was increased from 200°C to 250°C (especially, for LFP cells)
- large amount of tests was possible due to additional funding by BMDV (Project LiKlas)



# Tests of Commercial Sodium Ion Cells – 18650, 1.3 Ah, atmosphere = air

- **Single Cell Tests @ 100% SOC**



→ no TR?!?

# Tests of Commercial Sodium Ion Cells –

18650, 1.3 Ah, atmosphere = air

- **Single Cell Tests @ 100% SOC**



→ rather violent reaction → TR!!

## Pictures of DUT

before test



after test

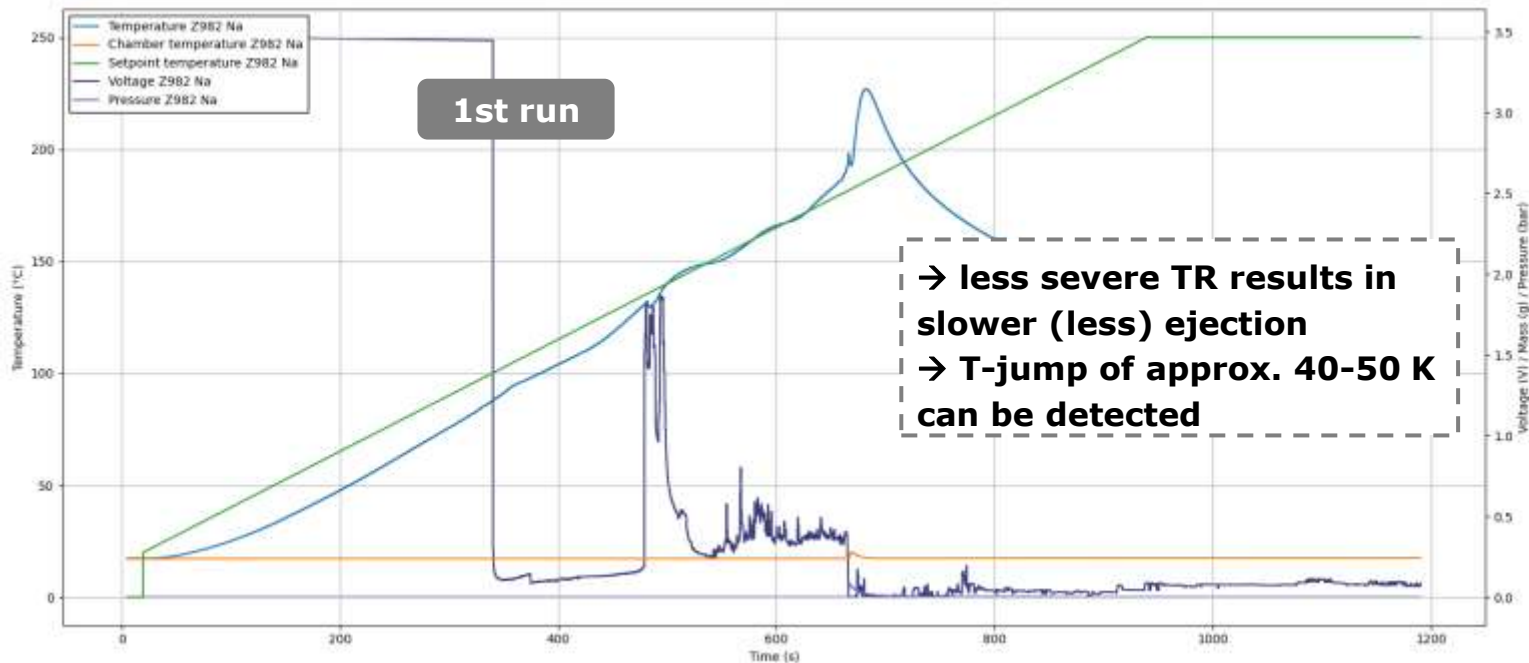


→ ejection of internal part (despite lid and rather strong fixture) hinders clear detection of TR by temperature change

# Tests of Commercial Sodium Ion Cells –

18650, 1.3 Ah, atmosphere = air

- **Single Cell Tests @ 70% SOC**



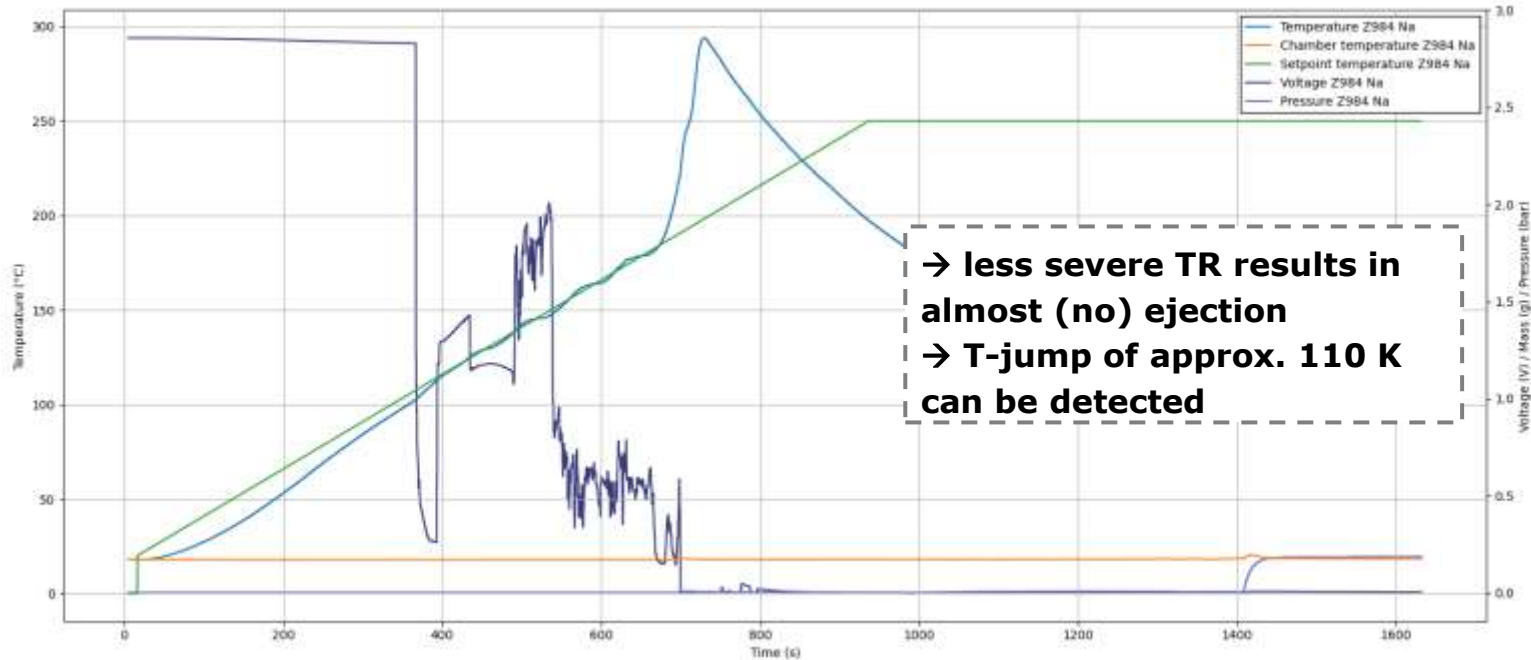
## Pictures after test





# Tests of Commercial Sodium Ion Cells – 18650, 1.3 Ah, atmosphere = air

- **Single Cell Tests @ 30% SOC**



## Pictures after test





# Tests of Commercial Sodium Ion Cells –

## Summary

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- **SIB-cells (can) react similar to LIB-cells**
  - **even at 30% SOC TR is clearly detectable**
  - **strong ejection makes it very difficult to detect TR by temperature**
    - **also valid for LIB-cells**
- **propagation tests**
- **so far two runs with SIB-cells at 100%SOC**
    - **however, no propagation due to ejection**
  - **similar results are (most probably) observable for propagation of 21700 NCA cells (100% SOC)**
- **generally, clear definition about the validity of the tests is very important**
- **non-valid (e.g., clear ejection etc) → not passed**

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# Thank you for your attention!

## Contact:

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