GRILLO-Werke AG

Analysis and quality assurance of zinc materials for energy storage

NAATBatt SODIUM-ZINC BATTERY WORKSHOP

Houston, Texas Nov. 30 – Dec. 1, 2023

Agenda

Analysis and quality assurance of zinc materials for energy storage

GRILLO

01 Zinc battery materials

02 Analytical methods

03 Quality assurance

01

Zinc battery materials

Customized for every cell design

Zinc batteries

Variety of zinc-based energy storage systems – for a wide range of applications

Zinc battery materials

Optimized materials for every cell design

Zinc powder

Is there anything I need to watch out for?

Relevant parameters

- Element distribution
- Particle size distribution
- Apparant density
- Flow rate
- Gas evolution

02

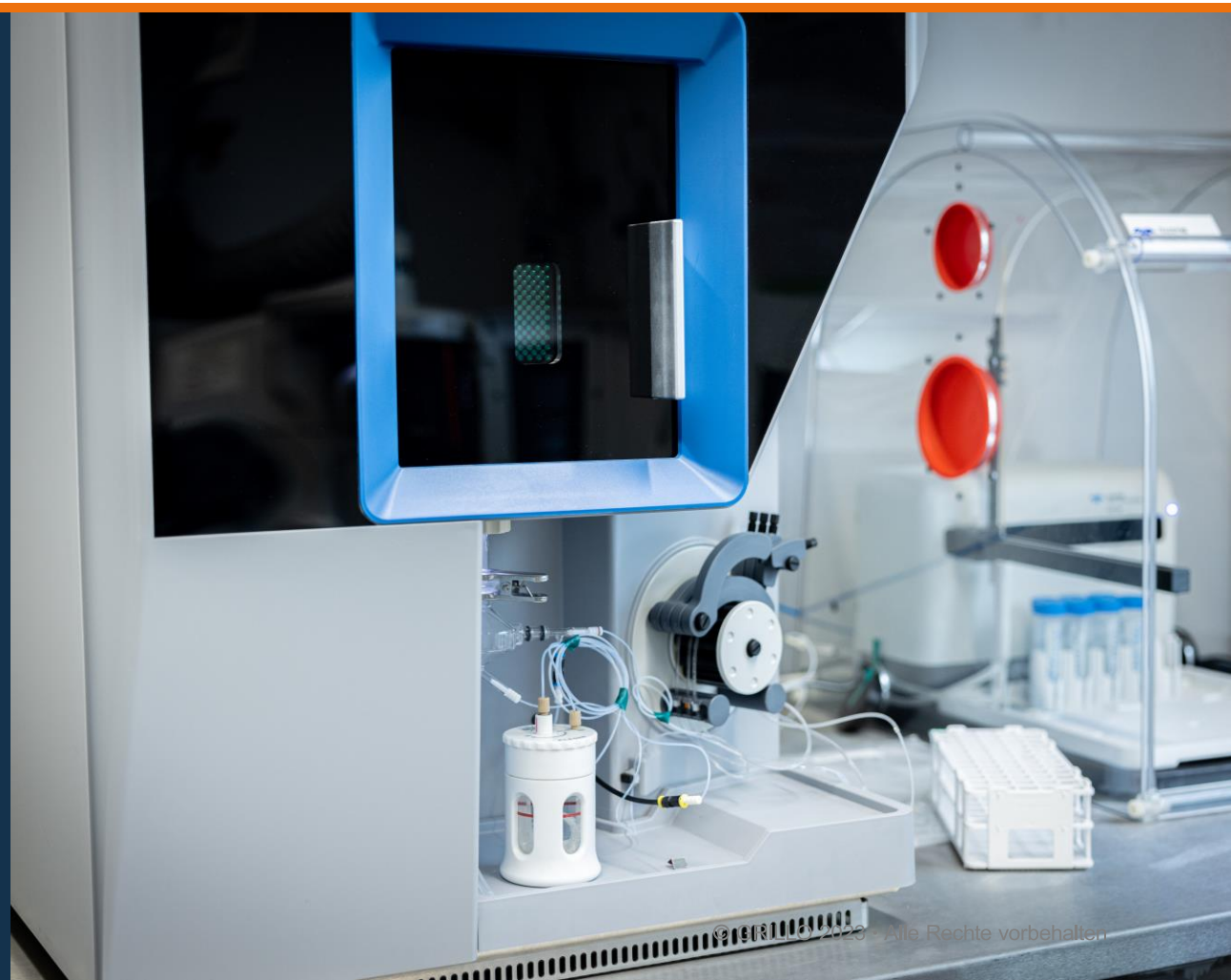
Analytical methods

How do you check your quality?

Element analysis I

ICP-OES (based on DIN EN ISO 3815-2)

- ✓ Simultaneous determination of alloying and trace elements
- ✓ High flexibility in measured elements and concentration ranges
- ✓ Measurement by autosampler without operator
- ✓ High measurement accuracy
- ! Sample preparation
- ! Measurement time



Element analysis II

Optical (Spark) Emission Spectrometry (based on DIN EN ISO 3815-1)

- ✓ Simultaneous determination of alloying and trace elements
- ✓ High flexibility in measured elements and concentration ranges
- ✓ High measurement accuracy (alloying elements)
- ✓ Measurement time
- ! Acceptable measurement accuracy (trace elements)
- ! Sample preparation
- ! Measurement only with operator

Particle size distribution

Sieve analysis

Particle size distribution

- **according to ASTM B 214 (vibration sieving)**
  - The sieves are placed on top of each other, with the sieve with the largest mesh size on top.
- **according to DIN EN 993-10 (air jet sieving)**
  - Standard method (entire sample quantity on the finest sieve, transfer to next coarser sieve)
  - Swiss method (sample divided into the number of grain size classes; representative sample division is important)

Physical properties of Zinc Powders

Bulk density, flowability

Flowmeter with precision opening

- 1/5” diameter ➔ Carney-Funnel
- 1/10” diameter ➔ Hall-Funnel
- Precision density cup (25 cm^3)

Flowability

- according to ASTM B 213

Bulk density

- according to ASTM B 212

Gas evolution test

How much hydrogen is generated?

Special "non-cellular" gas evolution test method

- zinc powder sample is placed in a closed glass flask, which is filled with the battery electrolyte

Electrolyte

- Standard
- Customer specific (requires customer materials)
- Different temperatures possible

03

Quality assurance

Set rules and stick to them.

Raw materials

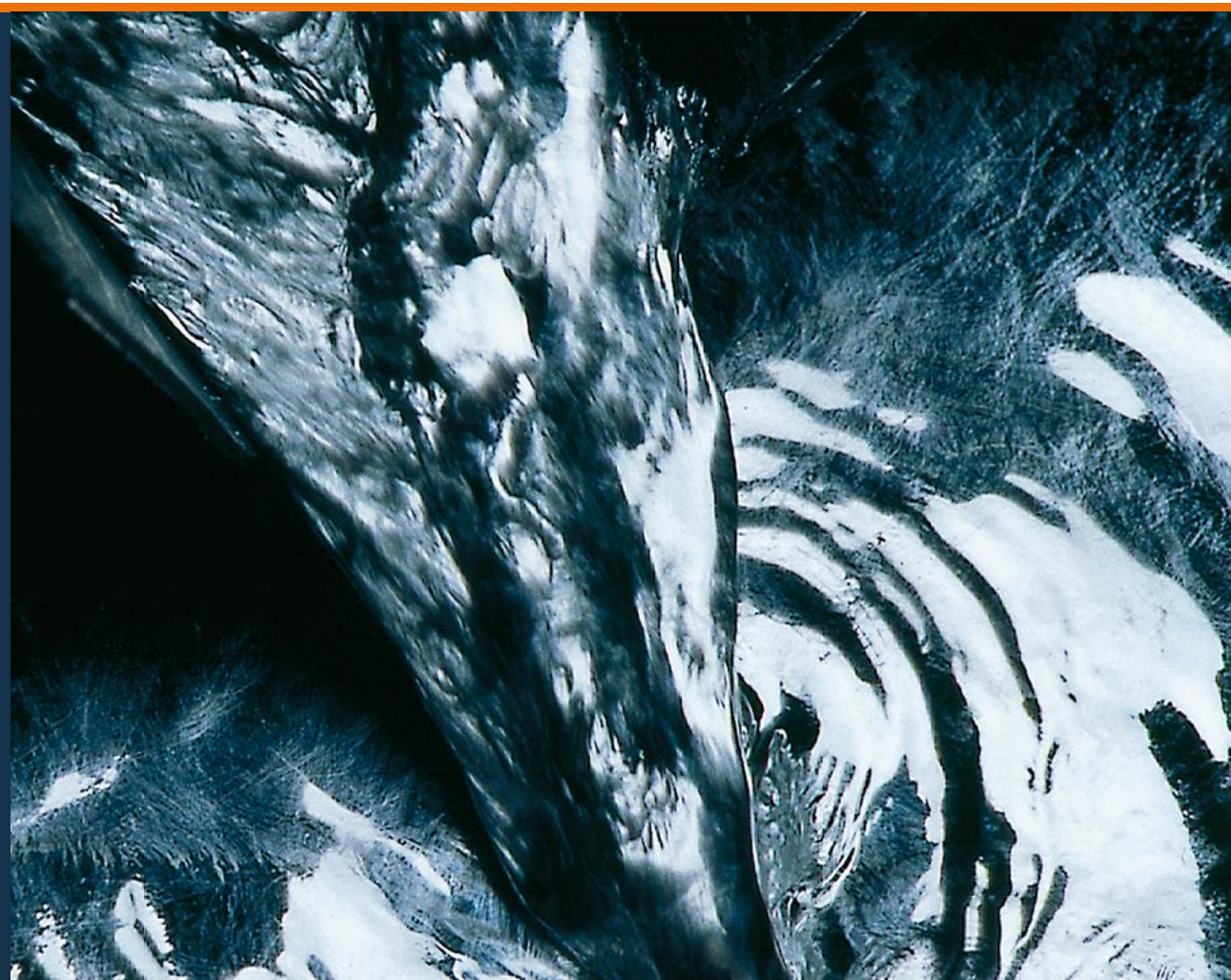
Checking the incoming

- **Technical discussion**
- **Audits of suppliers**
- **Qualified suppliers**
- **Incoming goods inspection**
  - Skip lot method

Processing

Checking the processing

- **Well developed processes**
- **Known and fixed parameters**
- **In-process control**



Product

Checking the final product

- **100% lot/batch control**
  - Control of every specified parameter (up to 40)
- **Special focus on element analysis and gassing behaviour**
- **Lab tests and results aligned with customer labs**
- **Retain sample of every lot/batch**

GRILLO

THANK YOU!

Think Zinc for sustainable energy storage.