Leclanché
Energy Storage Solutions

e-TRANSPORT SOLUTIONS

STATIONARY SOLUTIONS

SPECIALTY BATTERY SYSTEMS

PFAS-free electrodes for lithium-ion batteries - Leclanché

B3 Impulsvortrag

27.03.2026

Leclanché Overview

Key Figures

1909
Founded

375+
Employees

170+
Customers

50+
Electrochemists & Engineers

Dr. Hilmi Buqa Joined Leclanché in 2009
- Senior Scientist – High Power Lithium SA
- Postdoctoral Scientist – Paul Scherrer Institut
- 36 reviewed scientific papers, 10 patents issued
- PhD Lithium-ion technology (1996)

R&D Cells Team of Dr. Hilmi Buqa

Production

Cells

Packs

Made in Germany

Modules

Racks

Made in Switzerland

Key Markets Addressed

Advanced Li-ion batteries for heavy-duty commercial applications

Marine
e-MARINE

Rail
e-RAIL

Road
e-TRUCK

E-Mobility

Stationary
STATIONARY SOLUTIONS

Sustainability

- 100% renewable electricity used for all production
- Unique water-based electrode manufacturing process (no solvents)

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Leclanché Globally

Active Material Preparation → Lithium-ion cell Manufacturing → Module Assembly → Electronics Programming (Battery Management System) → Battery System Assembly → On-site Delivery, Final Testing & Commissioning → After sales Support & Monitoring


Germany


Switzerland



Marine Ground Stationary

Switzerland/Germany


Key Markets Addressed

Advanced batteries for heavy-duty commercial applications

Marine — e-MARINE

Rail — e-RAIL

Road — e-TRUCK

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Leclanché market

ALSTOM

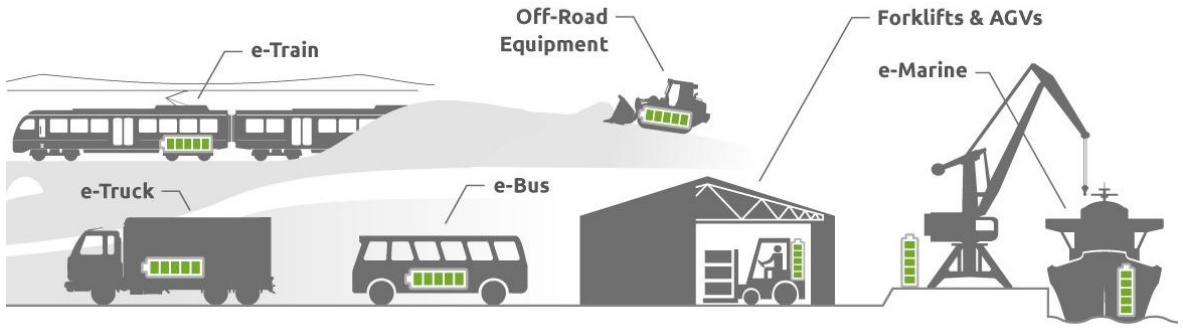
e-TRANSPORT SOLUTIONS

- Electric Buses
- Electric Ferries
- Warehouse Equipment
- Industrial Marine Electrification/Hybridisation
- Fleet Trucks
- Rail & Off-highway

Grimaldi Ro-Ro Series (9x)
Delivery: 2019 - 2022

GRIMALDI GROUP

URO



- → User profiles differ from automotive sector: permanent usage of battery
- → High cycle life is mandatory

Container

Yara Birkeland
Delivery: 2020

YARA

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Concerns around PFAS binders

Concerns Around PFAS

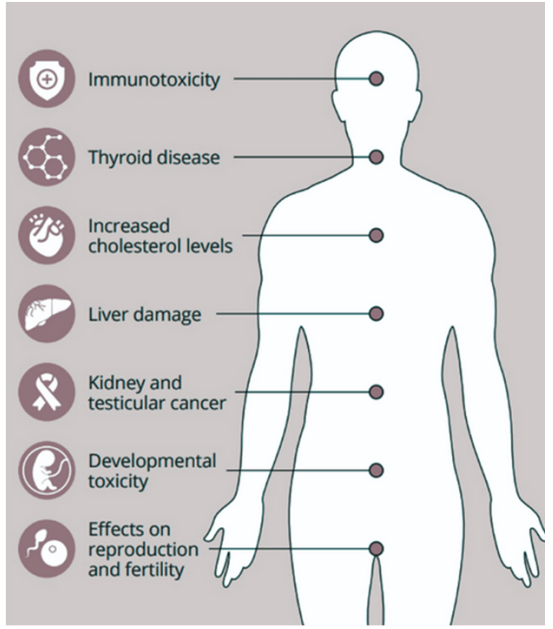
- PFAS (per- and polyfluoroalkyl substances):
  - Extremely persistent in the environment
  - Potential human health risks
- Regulatory Updates:
  - EU has banned certain PFAS
  - New draft legislation (2023) may expand the ban
  - ECHA reviewing 10,000+ PFAS under REACH (effective 2025)


Health hazard


Highly toxic

Leclanché's PFAS-Free Solution

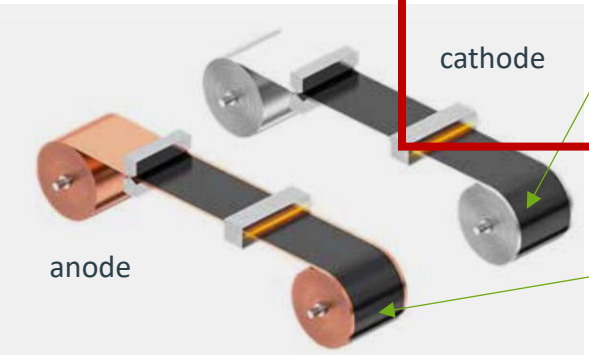
- Producing PFAS-free electrodes since 2023
- Cathode & anode slurries without PVDF
- Uses only PFAS-free, water-based binders



Brunn, H., Arnold, G., Körner, W. *et al.* PFAS: forever chemicals—persistent, bioaccumulative and mobile.

Use of PFAS in Li-Ion batteries

Todays topic



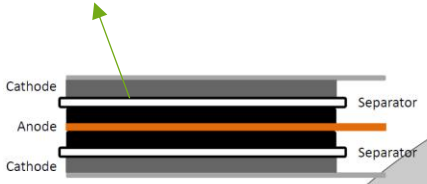
PFAS used as binder in combination with NMP

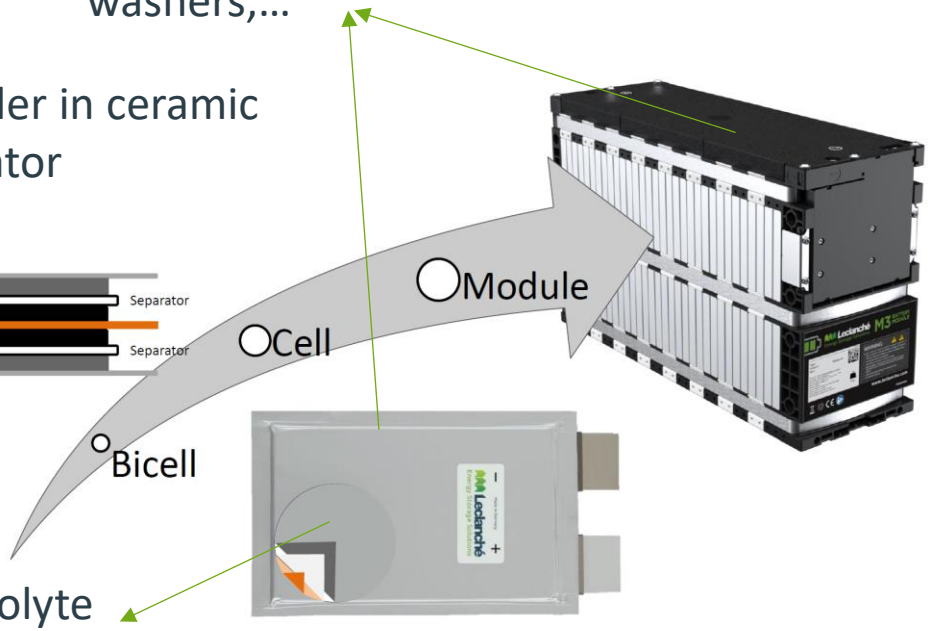
Usually no use of PFAS
→ water-based slurry & binder system

Disadvantages of PFAS
- Linked to severe health problems
- Typically used in combination with NMP which is by itself a health & safety hazard

PFAS might be used in connectors, valves, gasket, washers,…

PFAS might be used as binder in ceramic coating of separator





Advantages of PFAS
- Dispersion and adhesion properties
- Mechanical properties
- Thermal stability
- Chemical & electrochemical stability
  - High cycling stability
  - Voltage limit beyond 4.2 V

PFAS might be used in electrolyte

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History of Li-ion Cell Technology Development & water-based electrodes

2006: Acquisition of Bullith AG: a spin-off of the Fraunhofer Institute ISIT. Leclanché took over the technology developed in Li-ion cells and ceramic separators.

Fraunhofer ISIT

2014: Production of LTO/NCA cells and start of production for Graphite/NMC111 cells.

2023: G/NMCA cells with less cobalt and 20% increase energy density.

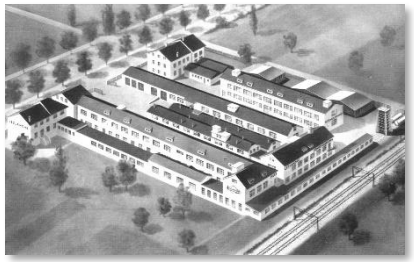
Li-ion cell development: prototyping phase

Li-ion cell development: pilot phase

Li-ion cell production at industrial scale:

- **> 11 years of production experience using exclusively water-based electrode manufacturing**

1909 — 2006 — 2012 — 2014 — 2019 — 2021 — 2022 — 2023



1909: Leclanché SA is founded in Yverdon-les-Bains, Switzerland.

2012: Leclanché installs a Li-ion cell production plant in Willstätt, Germany.

2019: High energy Graphite/NMC622 Li-ion cells production

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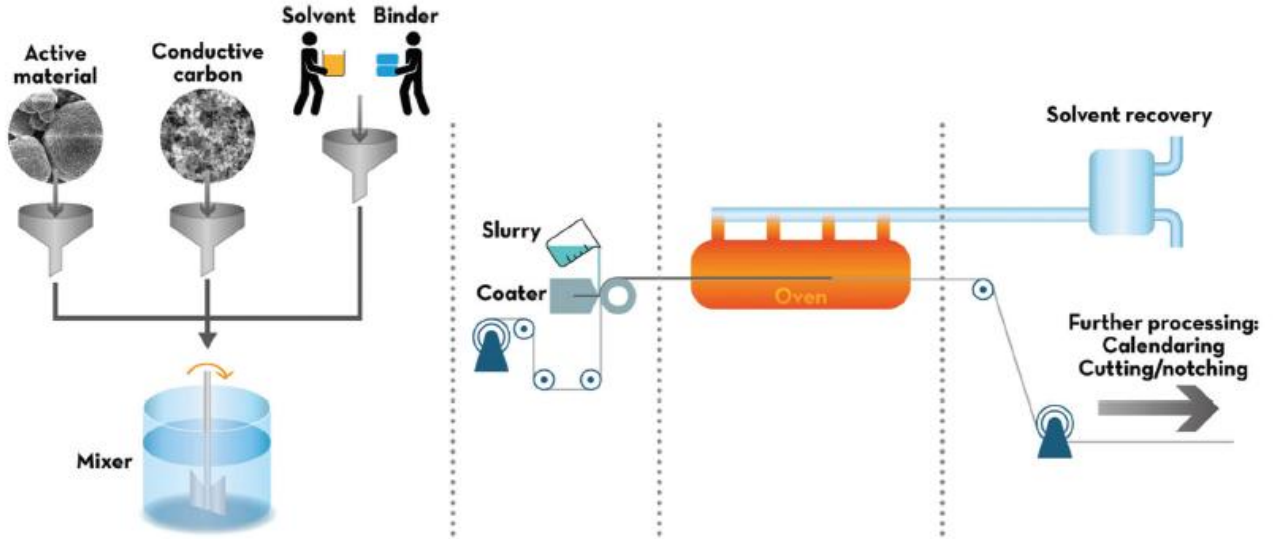
Over 13 years of knowhow in the large-scale production of Li-ion cells using a water-based binder process for the anodes and cathodes



Solvent	Mixing	Coating	Drying	Recovery
NMP	Hazardous handling requires ventilation system and PSE	Controlled enviroment needed	Solvent vapours need to be collected to avoiding dispersion in the atmosphere	Recovery system required to recycle the expensive solvent
Water	PSE only required for handling of powders	Can be performed in air	No recovery necessary	Not needed

Water-based Process for Battery cell Production

Energy savings compared to traditional solvent based

- Lower electrode drying temperature (50-60°C lower)
- No solvent recovery system (lower Capex and Opex)
- Reduction in humidity control space (70-80% reduction)
- Cell cost reduction of up to 10% compared to solvent based [(1)]

Leclanché's production line manufactures only water-based binder electrodes

D. Bresser, D. Buchholz, A. Moretti, A. Varzi, S. Passerini, *Alternative binders for sustainable electrochemical energy storage – the transition to aqueous electrode processing and bio-derived polymers*, Energy Environ. Sci., 2018, 11, 3096.

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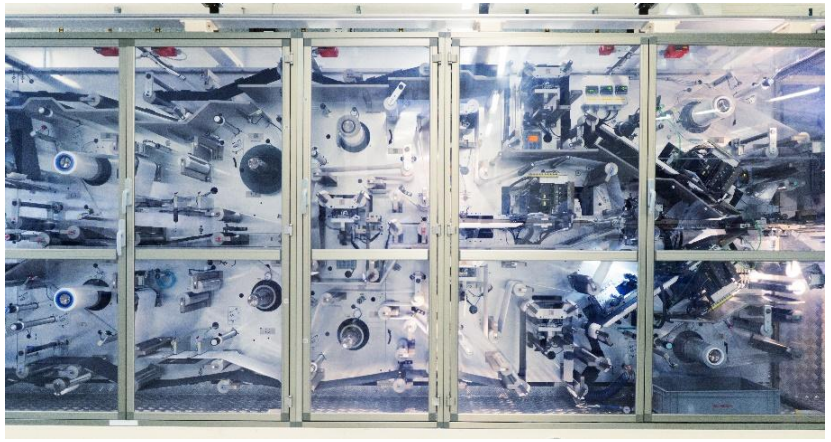
[(1)] Ref: Journal of Power Sources 275 (2015) 234-242

Process chain at Leclanché



Electrode preparation

- Slurry preparation
- Coating and Drying
- Calendaring
- Notching

Cell assembly

- Bi-cell assembly
- Stack assembly
- Vacuum drying
- Electrolyte filling

Cell finishing

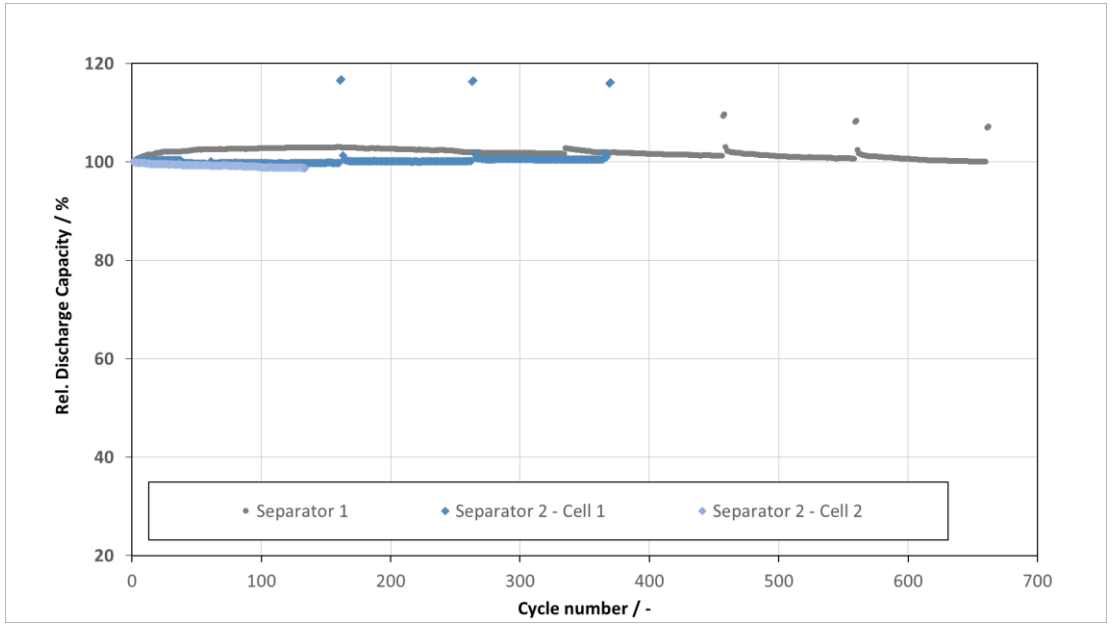
- Ageing
- Formation
- Degassing
- Quality check

Summary

Advantages of non-PFAS

- Dispersion and adhesion properties
- Mechanical properties
- Thermal stability
- Chemical & electrochemical stability
  - Higher cycling stability than cathode containing PFAS
  - Voltage limit beyond 4.2 V
- No health risk due to avoidance of PFAS
- No health & safety risk due to avoidance of NMP as solvent

Overall PFAS-free cell in Minipouch format (1.5 Ah)



→ No disadvantage in usage of PFAS-free electrodes on cell level could be found

→ PFAS-free cell manufacturing is possible with shown electrochemistries

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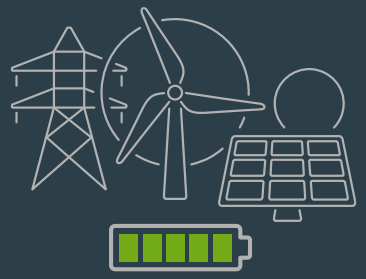

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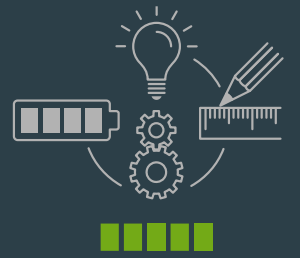

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