IS SOLID-STATE FOR EVs JUST AROUND THE CORNER ?

PROMISING REAL-LIFE ACHIEVEMENTS

Blue Solutions is Part of Bolloré Group

→ **Blue Solutions is 100% owned by a family-controlled, diversified group**

TRANSPORTATION & LOGISTICS

One of the world's leading transportation groups.

BOLLORÉ TRANSPORT & LOGISTICS

COMMUNICATION

Integrating content, media & communications businesses

vivendi

ELECTRICITY STORAGE & SYSTEMS

Development and production of solid-state batteries.

BlueSolutions a Bolloré

BOLLORÉ

Founded in 1822 as " Papeteries Bolloré ", family-owned, specializing in the production of thin paper. It grew to become the Bolloré Group, one of world's 500 largest commercial groups.

Publicly listed, majority controlled by the Bolloré family and chaired by Cyrille Bolloré since 2019.

The stability of its shareholder base enables it to pursue a long-term investment policy.

Today the Bolloré Group represents around 81 000 employees in 127 countries with annual revenues of €25 billion.

On the road to a technological breakthrough

→ Building on a decades long R&D and manufacturing experience to develop the technology of the future

1980s

Collaboration between French (**CEA/CNRS**) & Canadian (**Hydro-Québec/IREQ**) to develop a new polymeric electrolyte with lithium salt

2001

In Canada, creation of **Avestor,** a 50/50 JV between Hydro-Québec and Kerr-McGee

In France, a partnership between CEA, EDF & **Bolloré** leads to the creation of **Batscap**

2001

2007

Bolloré Group acquires Avestor and the merger with Batscap results in **Blue Solutions**

2011

1st electric car equipped with a 1x30 kWh pack providing a 250-km range

2015

1st electric bus, equipped with 8 x 30 kWh packs providing a 180-km range

2018

Contract with **Daimler** to equip their eCitaro electric buses

TODAY

LMP®

Targets specialized markets such as electric buses, off-highway vehicles, etc.

> 2026

Gen4

Designed for the EV mass market

BlueSolutions BOLLORÉ

International assets and manufacturing plants

→ Proven experience in industrial R&D and large-scale manufacturing

MANUFACTURING FACILITIES PRODUCING LMP® BATTERY CELLS AND MODULES FOR 10+ YEARS

2 FACTORIES

France and Canada : 48,000 m²

- ISO 14001 (environment),

- ISO 9001 & **IATF 16949** (quality)

420 EMPLOYEES

Technicians and engineers dedicated to the battery business

PRODUCTION CAPACITY

Up to 1.5 GWh

600 MWh (2022)

COMMITTED TO R&D

2 R&D CENTERS

Canada & France

25+ YEARS OF R&D

Pioneer in solid lithium metal technology

~620 PATENTS

Covering electrochemistry & materials, design, and manufacturing

10 YEARS OF REAL-LIFE IMPLEMENTATION

Car-sharing activities, e-buses, off-highway, and stationary storage

WITH MANY LONG-TERM PARTNERS

cea

LABORATOIRE PMC

IMN INSTITUT DES MATÉRIAUX JEAN ROUXEL

Université de Montréal

LePMI Grenoble - Chambéry

Mateis

imp

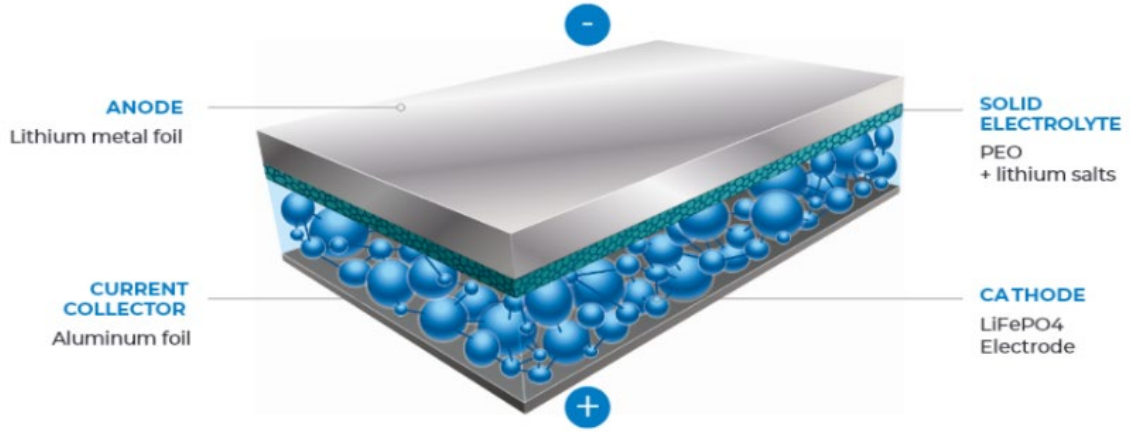
INRS UNIVERSITÉ DE RECHERCHE

Canada CNRC·NRC

CIC energiGUNE energy cooperative research centre

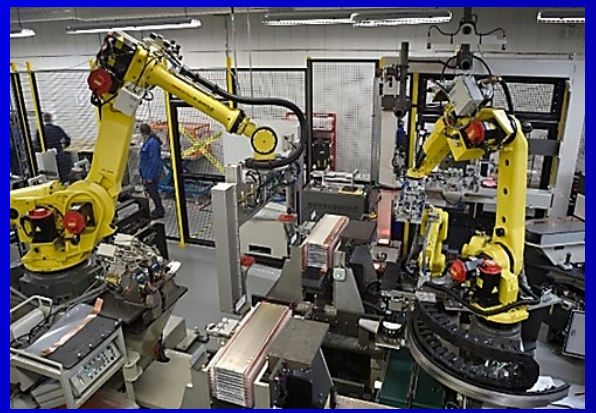
Proven expertise in solid-state technology

→ **Critical lessons learned and unique know-how**



To transition from the first coin cells produced in 1999 to the first commercially available battery modules, we had to overcome many challenges and develop an expertise that goes beyond the mere chemistry:

- Manufacturing and assembly process of **ultrathin films**
- Specific processes dedicated to the production of **a thin metallic lithium foil** (anode in lithium metal down to 20 µm thickness and **1 600 mm width**)
- Overcoming **interface challenges**
- **Avoidance of dendrites**
- Extrusion process
- Stacking of **several battery cell layers** (around 100 layers)
- A **dedicated recycling process** (industrial process readiness in late 2021 based on existing recycling pilot line)

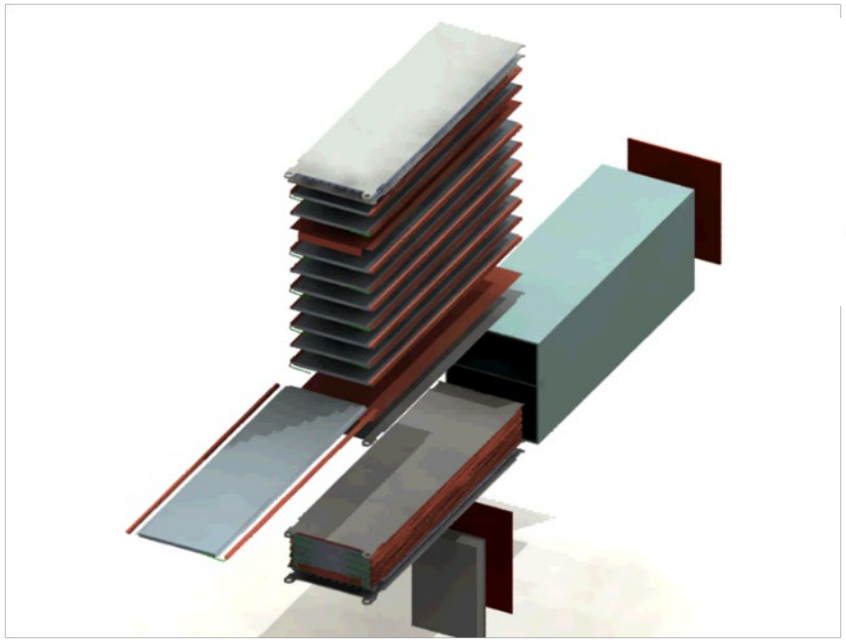


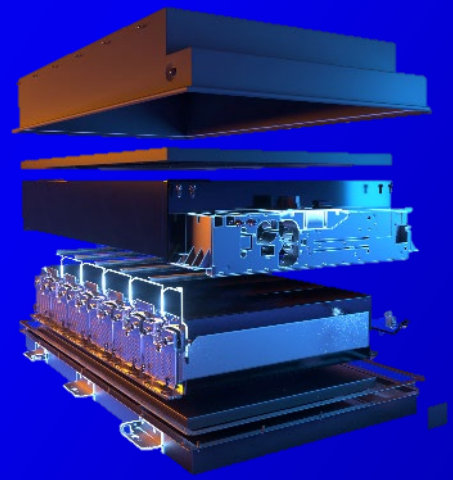
Producing the first commercially available solid-state battery

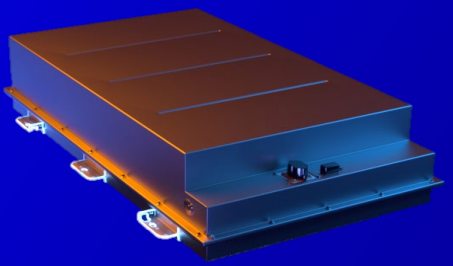
→ Targets are specialized markets such as electric buses or off-highway equipment

Remarkable key figures for a solid-state technology:

- **Capacity**: 120Ah (100 layers)
- **Cycle life**: 3 500 cycles @70% DOD
- **Internal temperature range**: 50°C to 105°C
- **Volumetric density**: 380 Wh/L (cell level)
- **Gravimetric density**: 255 Wh/kg (cell level)
- **C-rates**: C/4 for charge, 1C for discharge







Acknowledged & Adopted by Key Industry Leaders

→ More than a decade of sales all over the world

1. MOBILITY MARKET

DAIMLER — Blue Solutions' batteries power **Mercedes Benz's** latest generation **eCitaro buses**

bluebus — **400+ buses produced and used in 60 cities globally**

ACTIA® — Integration of LMP® batteries in the brand-new **Denning 'Element' bus in Australia**

GAUSSIN MANUTENTION — **APM75t innovative electric port tractor** used in **New Zealand, Qatar and Cote d'Ivoire**

2. STATIONARY MARKET

RTE — RTE (French TSO) : Ringo project, **30 MWh installation** located in Southern **France**

Mini-Grids — **25+ microgrids** powering communities in **Africa**

500 MILLION KM

TRAVELED BY EVs, BUSES AND HEAVY-DUTY VEHICLES POWERED WITH LMP® BATTERIES

BlueSolutions BOLLORÉ

BlueSolutions' next frontier in solid-state technology: Gen4

→ **Gen4 dedicated to the automotive mass market industry**

MEDIUM TERM
Meet the auto industry needs

SHORT TERM
Incremental improvements

Today
Module density: 230 Wh/L
Charging rate: C/5

2022
Module density: 255 Wh/L
Charging rate: C/4

2025
Module density: 295 Wh/L
Charging rate: C/4

2026 > 2030
Gen4
Density: 20-40% > Li-ion
C-rate/Operating temp/Form factor = Li-ion
Safety > Li-ion
Architecture and manufacturing process similar to Li-ion

SHORT TERM

Continuous improvements to support growing demand:

- +30% energy density
- Improved charging and discharging rates
- Continuous module design optimization

MEDIUM TERM

MEET AUTO INDUSTRY NEEDS

FORMAT	CATHODE	ANODE
Pouch cell (or equivalent)	High-voltage cathode	Lithium metal

CYCLE LIFE	VOLUMETRIC DENSITY	GRAVIMETRIC DENSITY
> 1 000 cycles	1 200 Wh/L	500 Wh/kg

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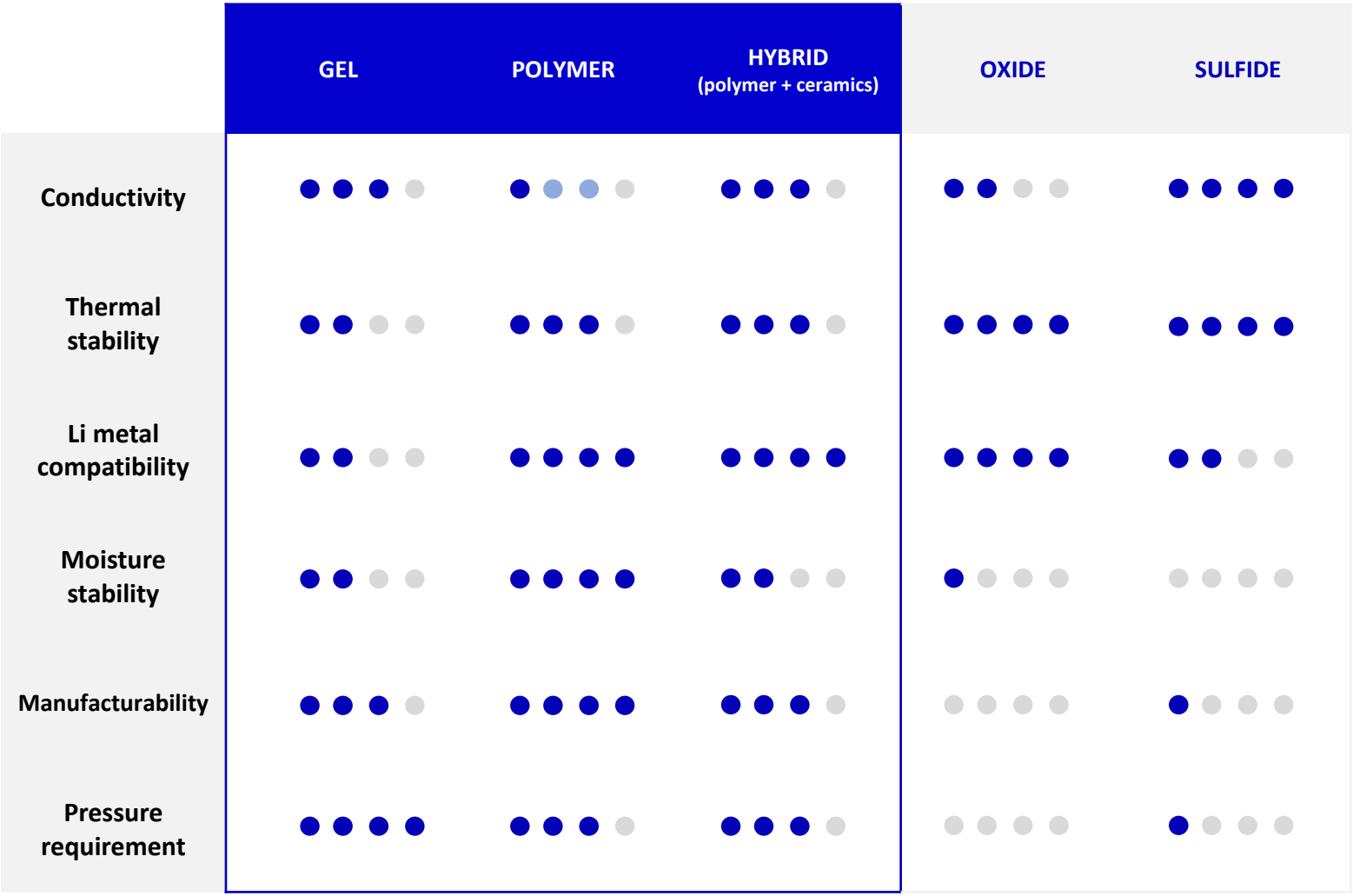
Several avenues are investigated to achieve Gen4 targeted performance

→ Based on lessons learned over 25 years in solid-state electrolyte experience and production



- Conductivity of basic polymeric electrolytes is not sufficient at room temperature
- Gel and hydrid can help bring down the temperature requirement
- Li-Ion organic solvent electrolytes unstable from 70-100°C. All solid electrolytes stable up to 250°C and more. Thermal stability will be defined by lithium metal anode (fusion at 180°C).
- Challenges related to foam with gels and to resistive passivation layer for sulfides
- Manufacturing challenge for all technologies
- But especially for ceramics, since process has to be in an inert atmosphere
- Gel, polymer and hybrid easy to manufacture using roll to roll process; harder to roll ceramics (especially oxides)
- One of the biggest challenges for solid state is integration, because of the pressure requirements

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GEN4: work package n°3

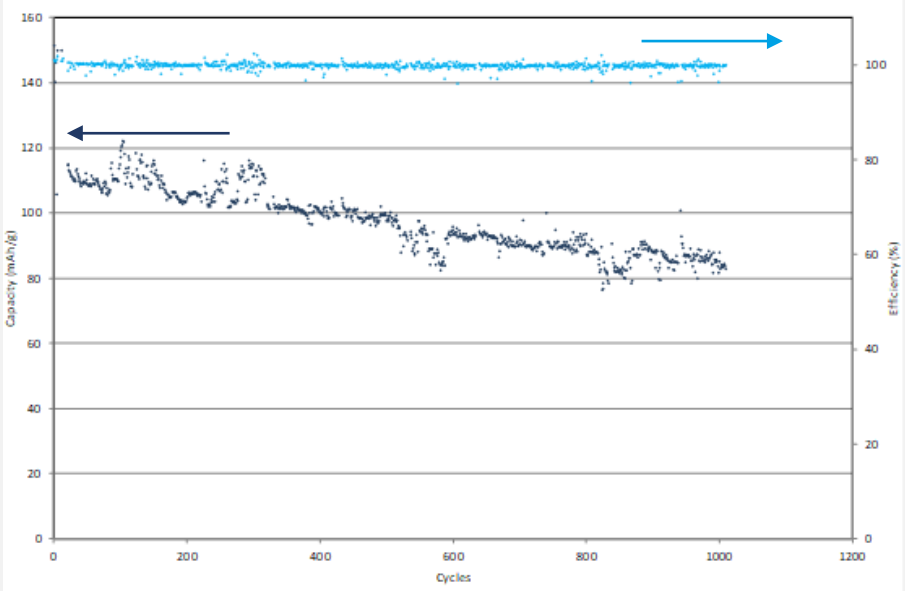
→ New chemistry working at room temperature with LFP cathode material

NEW CONCEPT

- **Anode**: Li metal anode
- **Separator**: polymer electrolyte
- **Cathode**: LFP cathode material

CYCLING CONDITIONS

- **Temperature**: 25°C
- **C-rate**: C/2
- **Voltage range**: [2.5V ; 3.6V]



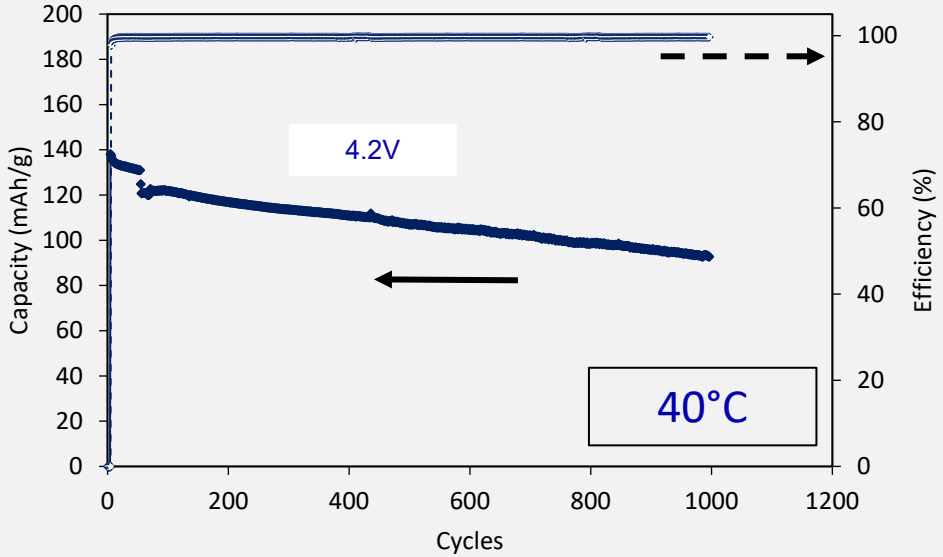
- No dendrite issues
- Long term cyclability

GEN4: work package n°5

→ New chemistry working at room temperature with high voltage cathode material

NEW CONCEPT

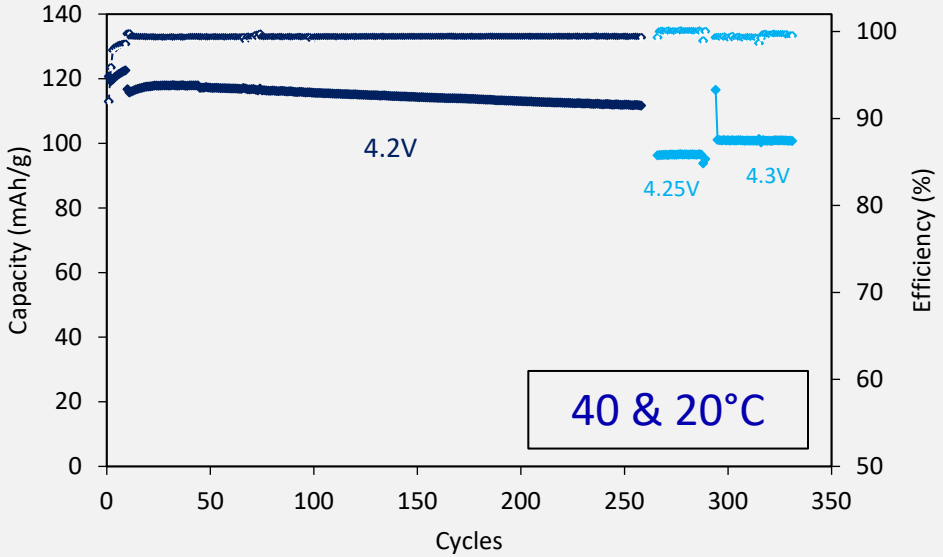
- **Anode**: Li metal anode
- **Separator**: confidential
- **Cathode**: high voltage cathode



- No dendrite issues
- Long term cyclability

CYCLING CONDITIONS

- **Temperature**: 20°C or 40°C
- **C-rate**: C/2
- **Voltage range**: [2.5V ; 4.2V] up to [2.5V ; 4.3V]



- No degradation even at voltages > 4V
- Very stable performances confirmed on new trials

Conclusion

→ **Is solid-state for EVs just around the corner ?**

YES!! Gen 4 is coming! … but prior to introduction in a series-produced car, a lot more than chemistry is needed!

- The right **compromise** between thermal stability, conductivity, cycle life….

- To go **from lab coin cells to production cells with > 20Ah capacity**

- A battery cell technology that can be **manufactured at "Giga-factory-scale"**

- The ability to **integrate** it into a car **with volumetric & weight constraints**

There is a challenging journey ahead!
Experienced players, **realism**, **technical partnerships** & **money** will be **key** to achieve it around 2026!

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MAKE A SOLID CHOICE!

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