

NASA AEROSPACE BATTERY WORKSHOP

Enhancing Battery Safety & Performance Through Optimized Current Collector - Electrode Interfaces



January 2026

Major challenges for batteries manufacturers

- ✓ Increase **power & energy density**
- ✓ Enhance **safety**
- ✓ Improve **cycle life**



Not everything works seamlessly at the electrode interfaces

High Internal Resistance

- Poor performance at high C-rate
- Hot spots, heat increase
- Temperature limits of operation

Risk of Corrosion

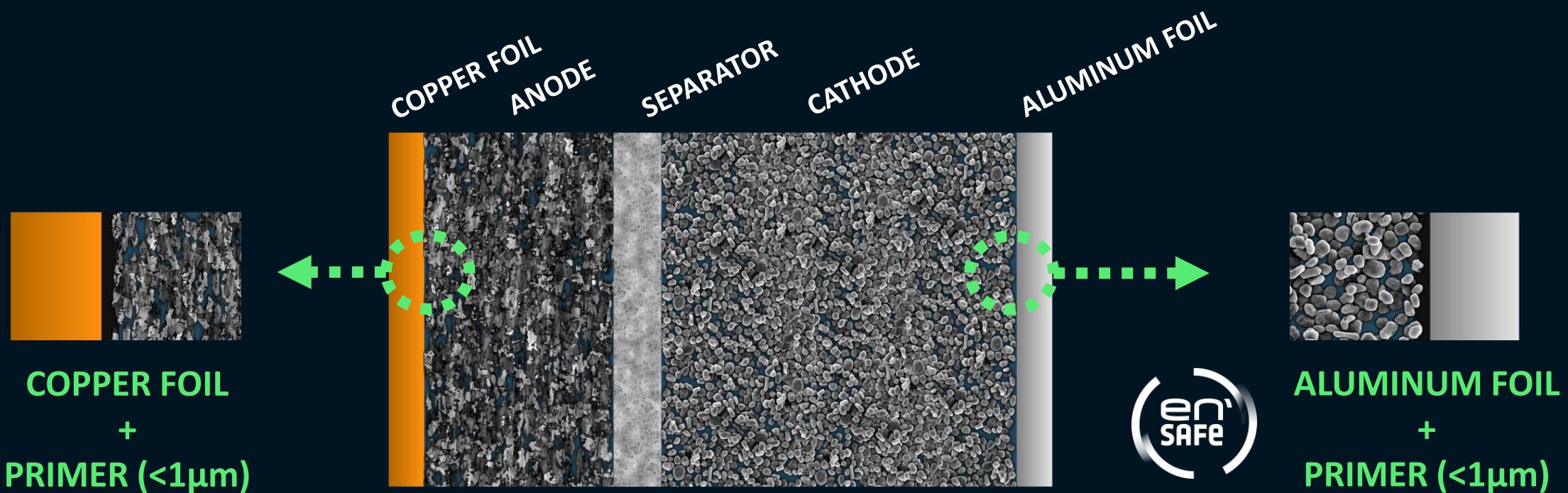
- Premature ageing
- Short circuits

Low Adhesion

- Electrode processing issue
- Premature ageing



Create a more cohesive interface with a primed current collector



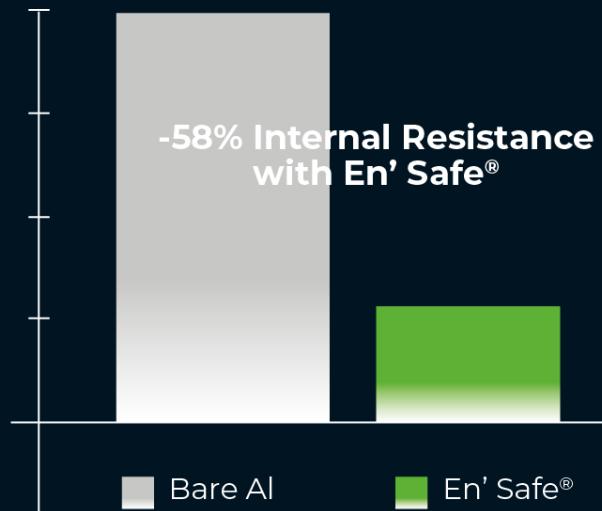
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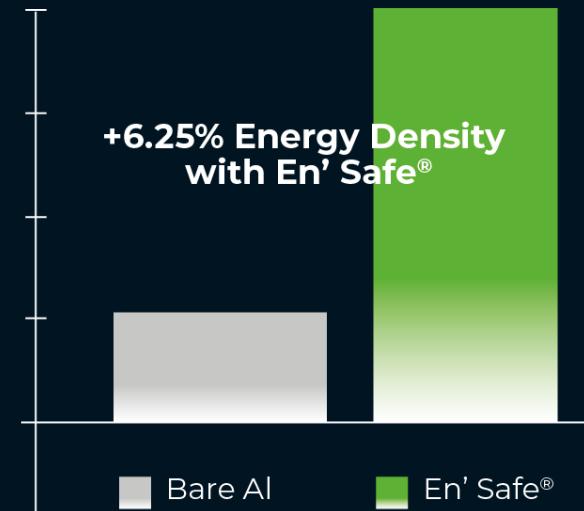


Increase power and energy density thanks to a lower internal resistance

REDUCING INTERNAL RESISTANCE



HIGHER ENERGY DENSITY



Using En' Safe® carbon-coated foil instead of bare aluminum foil lowers internal resistance and increases energy density

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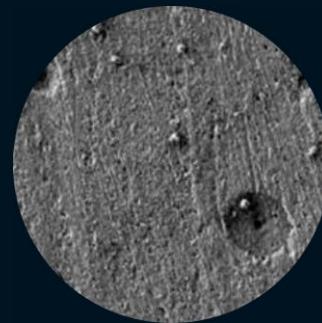
Advanced foil protecting corrosion for a maximum safety

Corrosion can occur during processing:

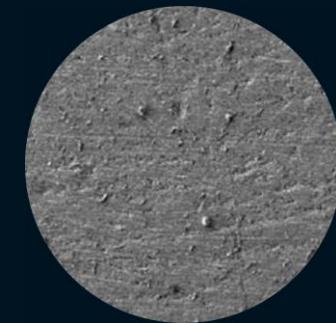
Water-based slurries – ex: NMC532, NMC622, ... (NMP free slurries)

Full range of pH compatibility : $1 \leq \text{pH} \leq 14$

Bare Al Foil

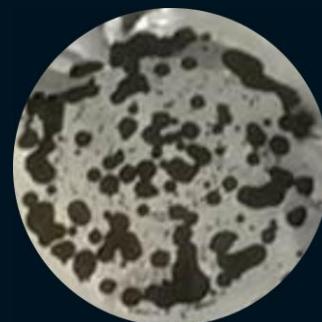


En' Safe® primed Al Foil



Corrosion can also occur during battery life:

- Corrosive salts in electrolyte - ex: LiTFSi (xTFSi; xFSi...)
- Aggressive chemicals - ex: polychlorates, sulfides,...
- Sulfur based electrodes

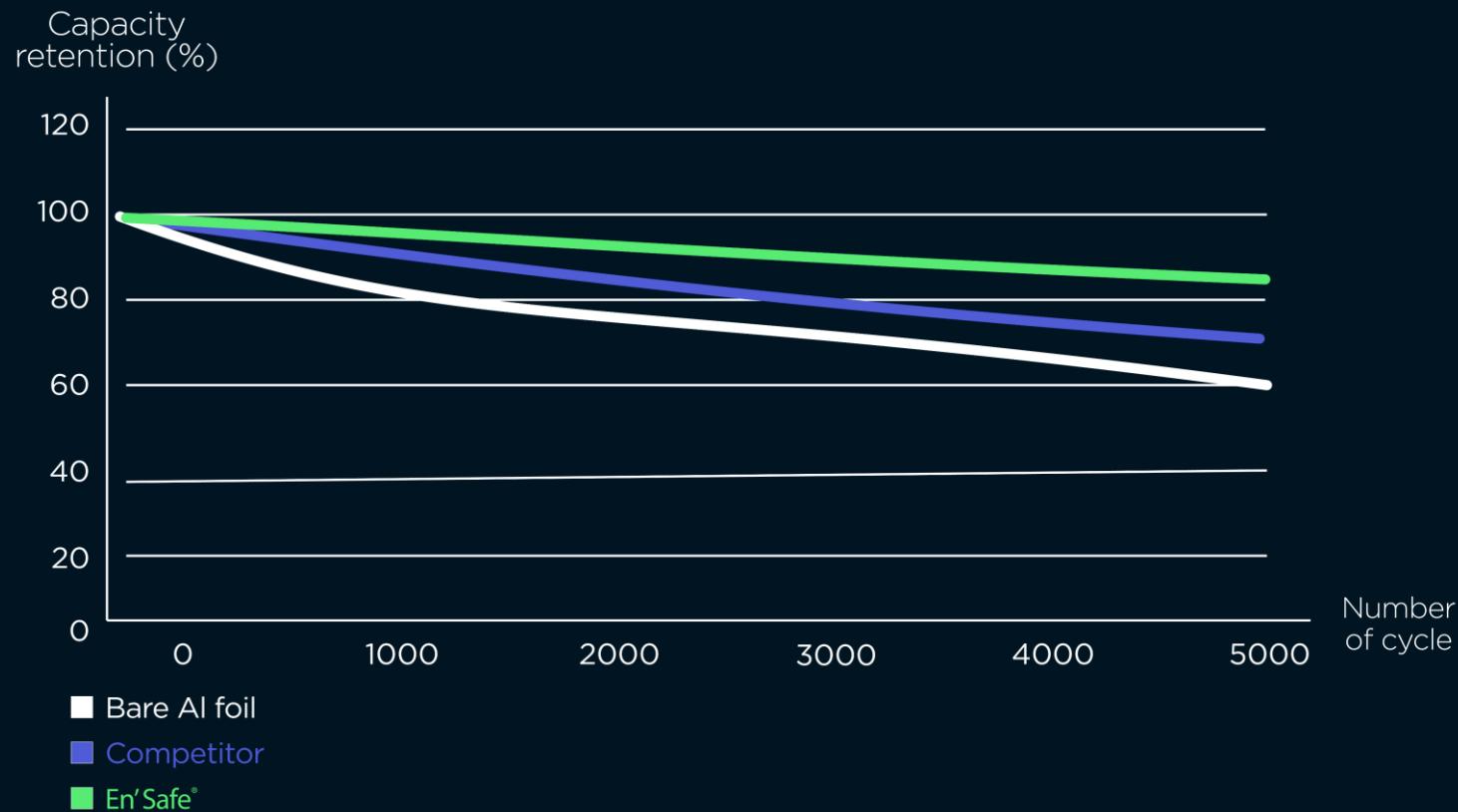


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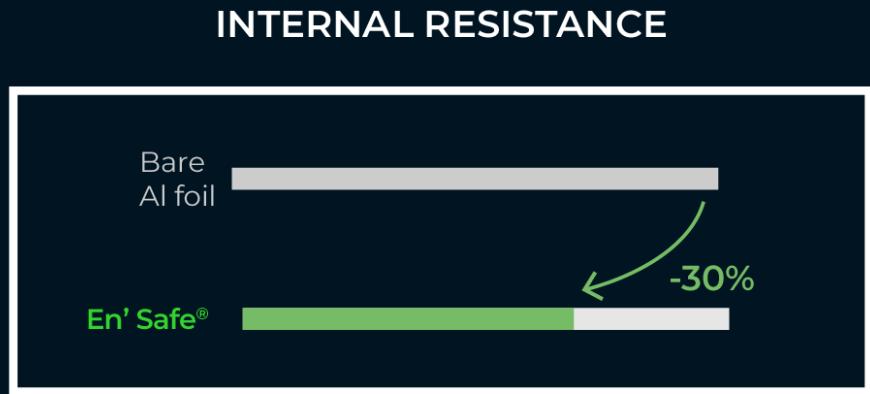


Better Capacity retention leading to a higher cycle life

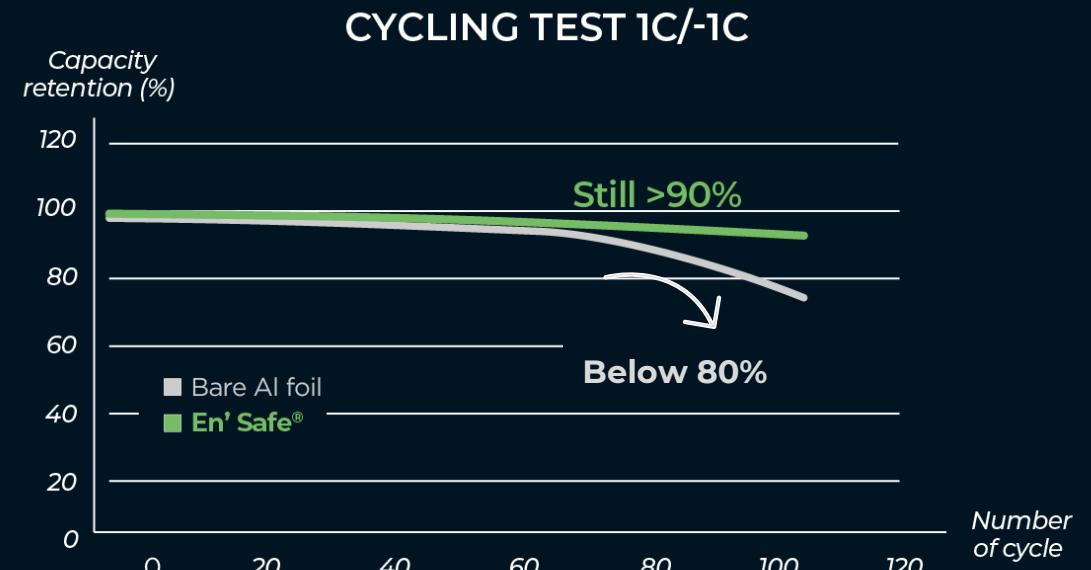


Higher capacity retention thanks to En' Safe

Real life NCA cells data



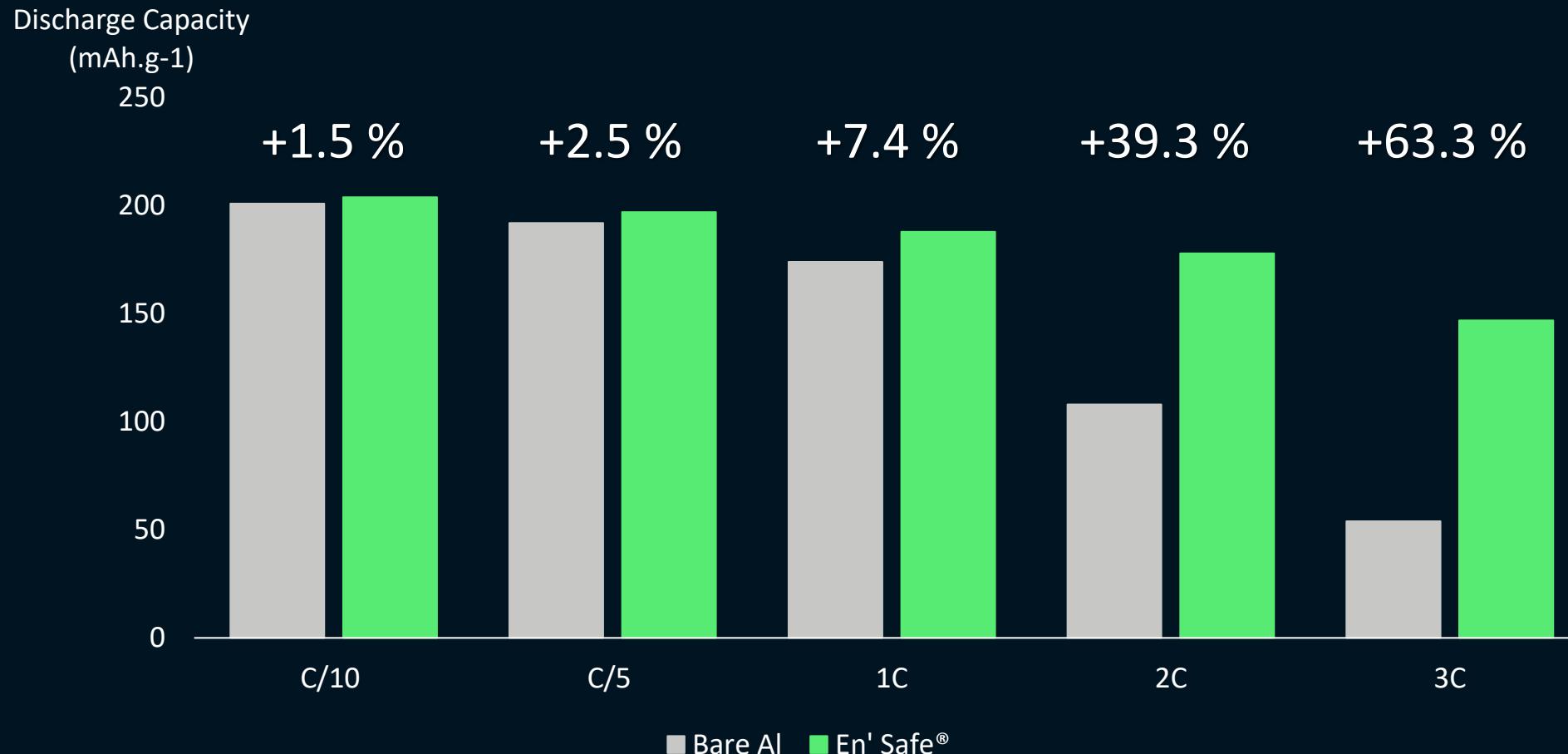
Lower internal resistance with En' Safe



Better cyclibility with En' Safe®

Real life NMC cells data

Higher discharge capacity thanks to En' Safe®



Proven solutions for future battery technologies

En' Safe® grades have been successfully tested for almost a decade with leading customers and academic partners on Li-S and Solid-State technologies.



En' Safe® key benefits



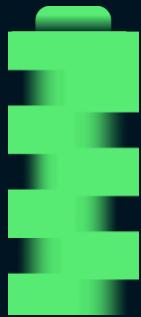
Adhesion



Corrosion



Power



Energy



Cycle life



Cost

Confidential

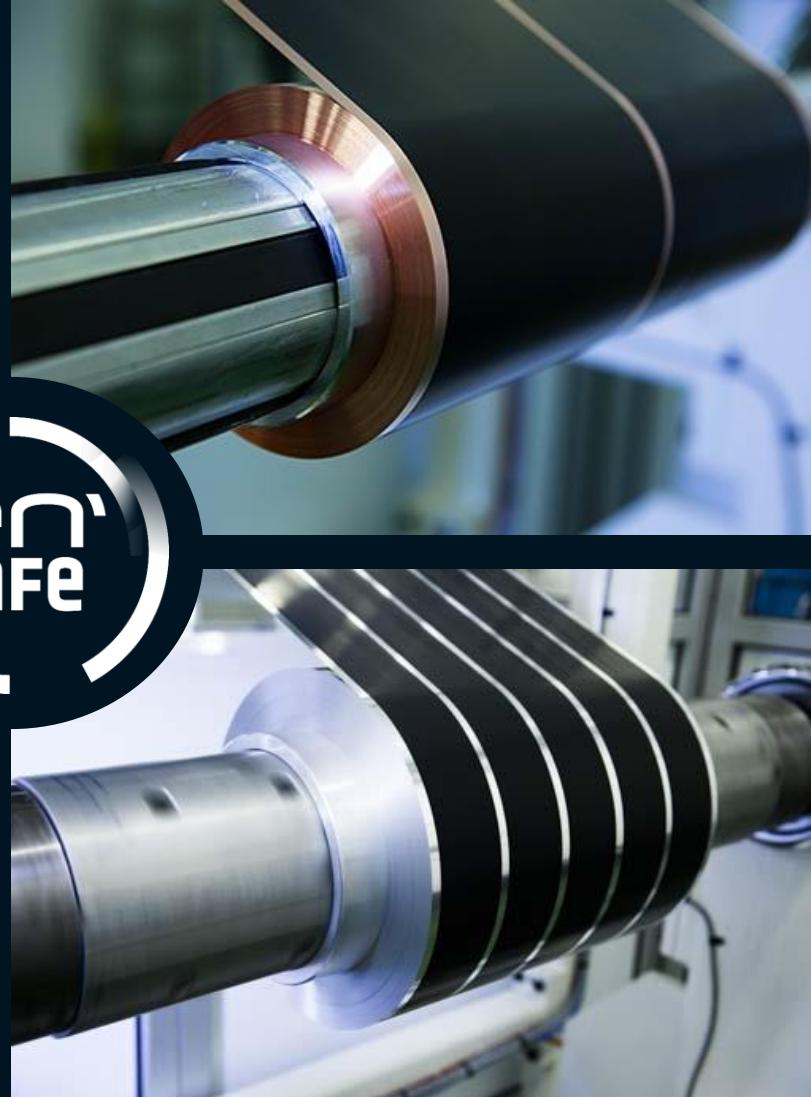
Wide product range required to cope with versatile applications

En' Safe®: a range of 12 commercialized primers for different applications

Applications examples

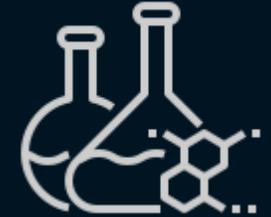
- Cathode: NMC, NCA, LFP, LMFP, LMNO
- Anodes: silicon-based, LTO
- Dry process
- Lithium-Sulfur
- Solid-state Batteries
- Lithium-ion 4,5 - 5,0V
- EDLC
- Sodium-ion

Etc...



What makes En' Safe® a unique primed Al/Cu foil?

We have a range a different primers



- **Primers : Formulation of state-of-the-art raw materials**

Extensive portfolio of conductive particles (CNT, graphites, carbon black, acetylene black) and binding systems



- **Al foils :**

High mechanical properties, long length available - Thickness = 9 to 30 μm

- **Cu foils :**

High purity , high mechanical properties -Thickness = Typical 6 to 14 μm



- **Coating Process :**

High precision, long length up to 20 000 m



- **Customized coating :**

Coating width, bare edges and patterns with one or several lanes can be adjusted on demand

ARMOR BATTERY FILMS facility

8500 m²

Footprint

150 Mm²/year

Production capacity (eq to 40GWh)

Expandable to 100GWh

500 m²

R&D laboratories



Part of ARMOR GROUP an indisputed expert on chemical formulation and high precision coating



THANK YOU!

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