



# Let's drive into the electric future together.

High-performance material solutions boosting battery packs.



# Covestro: your global electrification partner.

Increase energy efficiency and safety with lightweight battery packs.

The electrification trend in the transport sector is unstoppable and a key driver to reducing direct carbon dioxide emissions. By 2030 more than 25 million vehicles are expected to be sold worldwide, which means a compound annual growth (2020-2030) of 27%<sup>1</sup>. Players in the electric vehicle (EV) industry are focused on designing, optimizing and producing Li-ion batteries in EVs at scale in order to meet the expectations of OEMs and consumers.

- Resistance against abuse
- Flammability behavior
- Compact battery design
- Weight reduction
- Mass assembly efficiency
- Thermal management

These are some of the critical points in battery design which electric vehicle producers are working to optimize. We bring value to your battery pack by increasing energy density thanks to the versatility of our **Bayblend®** and **Makrolon®** solutions.

## Battery packaging solutions.

We are riding the electrification wave: a global team is committed to working directly with key players along the value chain in different market segments to design, develop, and produce battery packaging applications. Our thermoplastic amorphous polycarbonates and polycarbonate blends comply with the required high safety standards while providing the lightweight, robust high-tech solutions that battery operating conditions demand. We have a dedicated portfolio of grades for battery enclosures, module housings, top covers, and cooling devices that are suitable for most designs, while also meeting environmental guidelines such as ROHS<sup>2</sup> and WEEE<sup>3</sup>.

**Bayblend® is an amorphous, thermoplastic polymer blend of polycarbonate (PC) and acrylonitrile butadiene styrene copolymer (ABS) or a blend of polycarbonate and styrene acrylonitrile copolymer (SAN).**

- ➔ Excellent flame retardance
- ➔ High heat resistance
- ➔ High impact strength
- ➔ Low-temperature toughness
- ➔ High rigidity and high dimensional stability
- ➔ Low warpage and water absorption
- ➔ Good electrical insulation properties

**Makrolon® is an amorphous thermoplastic polycarbonate (PC).**

- ➔ Excellent flame retardance
- ➔ Very high heat resistance and toughness
- ➔ High dimensional stability
- ➔ High creep modulus
- ➔ Good electrical insulation properties
- ➔ Transparent and non-transparent colors

1) LMC Global Hybrid & EV Forecast 2021.

2) ROHS: Restriction of (the use of certain) hazardous substances in electrical and electronic equipment.

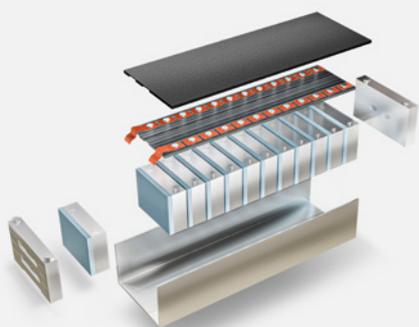
3) WEEE: Waste electrical and electronic equipment directive.



Our grades are available in different colors, flowabilities and with glass or mineral filler reinforcements.

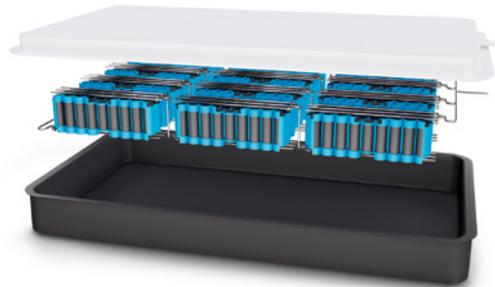
## Amorphous thermoplastics in EV battery packs.

Due to the amorphous nature of our polycarbonates and polycarbonate blends, their mechanical properties remain nearly constant over the battery operating temperature range without the need for reinforcement. In addition, battery manufacturers have chosen **Bayblend®** and **Makrolon®** over semicrystalline materials for many years because of their inherent flame retardance, high dimensional stability, and low moisture absorption. Our grades are proven and suitable solutions for a variety of battery cell formats used in electric vehicles while optimizing processability and scalability.



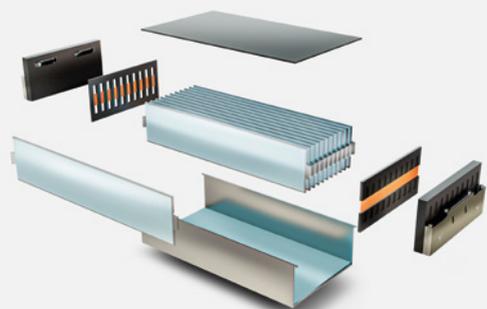
### Prismatic module

Highly innovative materials are used in items such as electrical insulation plates, busbars and module brackets.



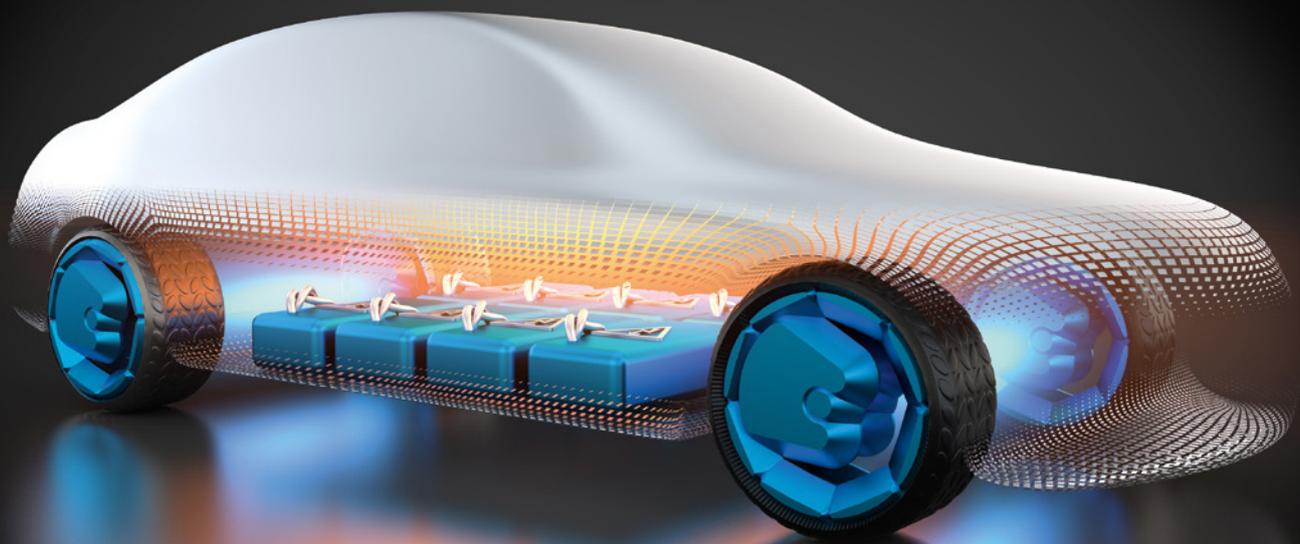
### Cylindrical module

Precise positioning of cells is ensured thanks to tight tolerances for complex shapes.



### Pouch module

Good material ductility accounts for swelling during charge and discharge cycles.



## Our solutions for battery packs:

**Bayblend® and Makrolon® ensure precise positioning of cylindrical and prismatic cells in holders as well as pouch cells in frames. The key properties that ensure outstanding behavior are:**

- ➔ Excellent flame retardance: UL94-V0 down to 0.75mm
- ➔ High dimensional stability and low warpage
- ➔ Tight tolerances for complex shapes
- ➔ UV-cured adhesive compability for cell fixation
- ➔ Excellent electrical insulation
- ➔ Relative temperature index: 80°C to 120°C
- ➔ Notched impact strength: min 35 kJ/m<sup>2</sup>
- ➔ Thermal conductivity on demand

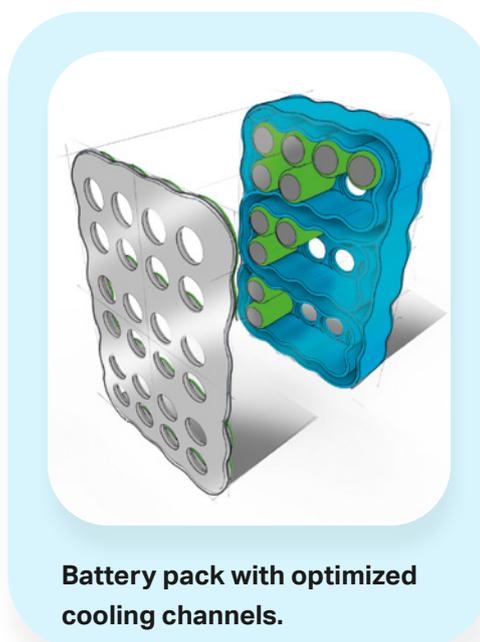
## Our grades in your battery packs:

The **Bayblend®** and **Makrolon®** product range includes high flow grades, grades for UV curing, reinforced grades, thermally conductive grades, grades for water/glycol coolant contact and flame retardant grades with UL94 V0 ratings at low wall thicknesses that are tailored to meet the varied customer needs for battery pack parts. We offer drop-in solutions with significant CO<sub>2</sub> footprint reduction cradle-to-gate while having properties identical to existing versions. You can recognize our new grades by the suffix RE: this indicates that these grades are attributed with bio-circular feedstock via the mass balance approach.

Bayblend® FR3042	Makrolon® TC110 FR	Bayblend® FR3010 RE
Bayblend® FR3010	Makrolon® 6487	Bayblend® FR3042 RE
Bayblend® FR3080 EV	Makrolon® 6555	Makrolon® 6487 RE
Bayblend® FR4065 EV	Makrolon® 6485	

## Effective heat management for electric car battery packs.

It is well known that uniform temperature distribution in battery modules improves the lifetime and ultimately the capacity of lithium-ion batteries. We offer thermally conductive polycarbonates such as **Makrolon® TC110 FR** for thermal management. These grades have thermal conductivity around 7 times higher than an average plastic, and thanks to their high functionality it is possible to position and integrate cooling channels directly onto the frames, resulting in increased battery capacity and power with fewer components. Additionally, our **Bayblend®** portfolio includes grades such as **Bayblend® FR4065 EV**, which is chemically resistant to water/glycol immersion in the optimal battery operating temperature range.



**Battery pack with optimized cooling channels.**

## Modular battery pack for light electric vehicles.

**Design and configuration** play a key role in how battery packs ultimately behave in terms of efficiency. We have developed a functional modular battery pack using our materials to perform abuse testing and to evaluate different design features and integration possibilities.

Our **Bayblend® FR**, **Makrolon® FR**, and thermally conductive **Makrolon®** series are some of the material solutions that have been used in the pack, from cell holders to external housings. This pack allows us to verify our simulation results for abuse tests and thermal management evaluations.



### Upper and lower cell holders

made of **Bayblend®** FR3080 EV and **Makrolon®** TC110 FR.

**Clever design techniques** allow the parts to resist mechanical loads, environmental conditions and satisfy performance requirements while reducing weight and complexity. Additionally, the use of thermally conductive materials has been proven to lower temperatures during charging which is known to help increase cell life in ongoing trials.



**Outer housing** using **Bayblend®** FR3040 EV or **Makrolon®** 6555.

## Recyclable battery covers using **Makrolon®** and **Bayblend®**

One clever way of molding thermoplastic materials into large parts as top and bottom battery covers is the long fiber reinforced thermoplastic direct (LFT-D) process. We have shown that by using **Makrolon®** and **Bayblend®**, these large parts have higher toughness and lower cycle times than other methods such as sheet molding compound (SMC). **Makrolon®** and **Bayblend®** based LFT-D covers can also pass required ingress protection tests, stringent flame retardancy requirements, and can be easily recycled while producing a carbon footprint half that of a thermoset material using the same process.

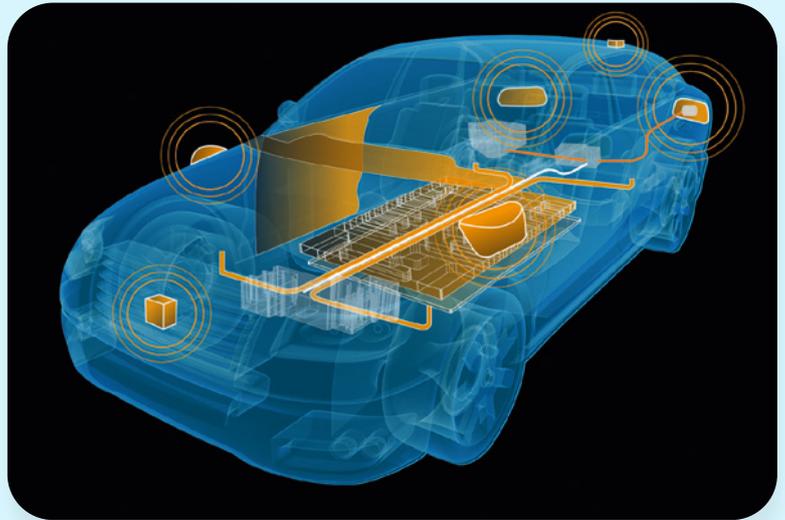


EV Top cover made of **Bayblend®** FR3090 LFT

# We are your global partner along the value chain.

**Global supply of high-quality materials to meet customer application needs.**  
**Global research and development.**  
**Global application development.**

- Assist in design, engineering, and processing
- Experience in implementing customer designs using our materials
- CAE tools, material data and know-how
- Field technical representatives for on-site production support at the customer.



**We work directly with OEMs, their molders and tier suppliers.**

## Get in touch with us:

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**Scan this code for  
more information  
about battery packaging:**



## Covestro fully embraces the Circular Economy:

We at Covestro are committed to becoming fully circular. Our drop-in solutions ensure fast implementation under the same processing conditions, at no technical risk and with identical high quality and properties. Our renewable-attributed ISCC PLUS-certified RE Series utilizes bio-circular feedstocks via a mass balance approach, and green electricity where available, resulting in significant reductions in the final product carbon footprint. Thanks to this, some of our **Makrolon®** RE grades are even climate neutral. Additionally, our **Bayblend®** FR RE series offers drop-in solutions with a significant carbon footprint reduction down to one-third of the traditional version in a cradle-to-gate approach. Additionally, we have grades available that contain up to 50% post-industrial recycled polycarbonates to support the recovery of our materials from end-of-life of products while preserving their flame retardant classification.

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