Taking the next steps to electrify mobility with premium polycarbonates

Steven Daelemans

Market Development EMEA

Mobility - Electric Vehicle Platform

covestro.com

Contact

Steven Daelemans

Covestro – At a glance

Global presence with global products

Covestro

- €14.4 bn in sales[1]
- 18,000 employees[2,3]
- 50 production sites[3]
- 1,500 employees in research and development[3]

Polycarbonates & components for polyurethanes

Industries

- Automotive and transportation
- Construction
- Wood and furniture
- Electrics and electronics
- Chemicals
- Sports / leisure, cosmetics, health and others

Engineering Plastics

- Mobility / Electromobility (Interior, exterior, lighting & e-platform)
- Electrics & Electronics
- Health Care

Makrolon®
Amorphous, dimensional stable & impact resistant polycarbonate (PC)

Bayblend®
PC+ABS or PC+ASA adding excellent low temp. toughness to PC

Apec®
Outstanding heat resistant polycarbonate co-polymer

Makroblend®
PC+PET or PC+PBT Ultra tough engineering blends

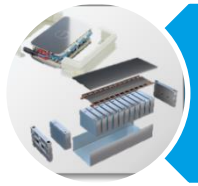
[1]Financial year 2023
[2]calculated as full-time equivalent (FTE)
[3]Financial year 2022

New Chances For Plastics In A New Environment

The combustion engine is outdated

Electrifying Mobility with Premium Polycarbonates

Agenda



3 in 1 Polycarbonates

Bayblend® FR, Bayblend® T, Makrolon® FR

Three benefits in one material for batteries & electronics encapsulation
- Precise molding with low warpage materials
- Stable mechanical properties over temperature
- Low carbon footprint of Makrolon® PC

Extended lifetime

Makrolon® TC for heat dissipation

Benefit from extended lifetime of batteries & electronics through
- Material inherent heat dissipation allowing for the avoidance of hot spots
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Combining the best of two material worlds

Flame retardant high CTI polycarbonates for high voltage applications

Benefit from the advantages of PC when requiring excellent electrical properties (incl. CTI 600V)
- Low and predictable shrinkage & warpage
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- Excellent ductility

Reducing carbon footprint even further

Covestro will be fully circular

Benefit from drop-in solutions of our well-established grades
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- The RE version will reduce the carbon footprint down to 0, depending on specific grade

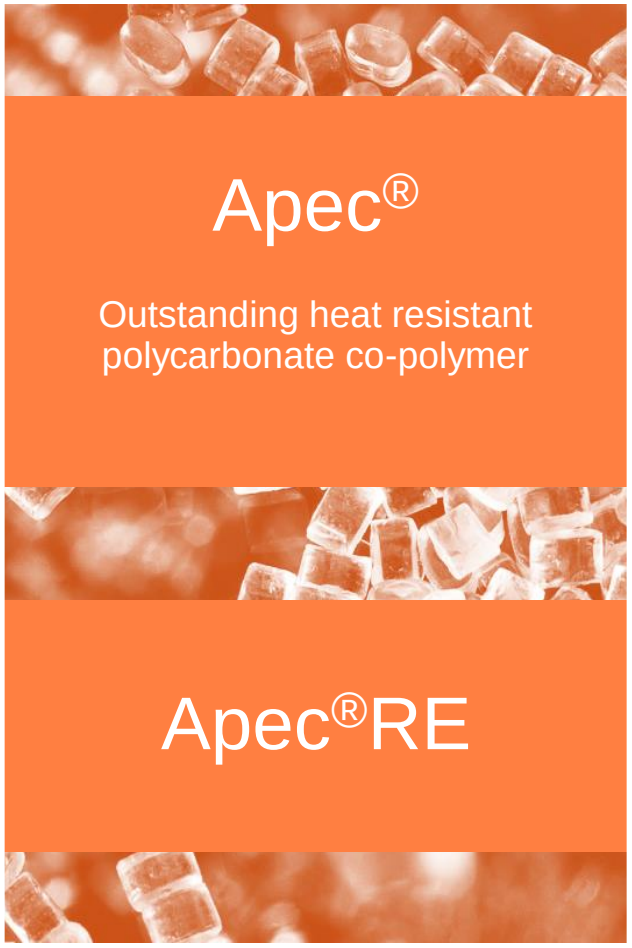
Covestro Polycarbonates RE Portfolio

Building a drop-in portfolio based on ISCC PLUS certified feedstock

Makrolon®

Amorphous, dimensional stable & impact resistant polycarbonate

Makrolon®RE



Apec®

Outstanding heat resistant polycarbonate co-polymer

Apec®RE

Bayblend®

PC+ABS or PC+ASA blends adding excellent low temperature toughness to polycarbonate

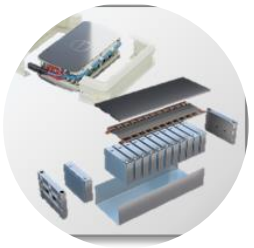
Bayblend®RE

Makroblend®

Ultra tough engineering PC+PET or PC+PBT blends

Makroblend®RE

Picture(s): Covestro, 2018



3 in1 Polycarbonates

Dimensional stable materials with constant mechanical properties allowing for automated mass production

Benefits of PC & PC+ABS FR

- High dimensional stability, **low & predictable warpage**
- **Constant mechanical properties** over a large temperature range
- **Low carbon footprint of PC**
  (PC: European average 3,4 kg CO_2 eq. emission per kg materials[1])

Further properties

- **Excellent toughness**, ductile break in ball drop test
- **Fire resistance**:
  UL94V-0 down to 0.75 mm wall thickness
- **High heat resistance**
- **Low density** resulting from possibly unnecessary GF reinforcement, may support component cost reduction

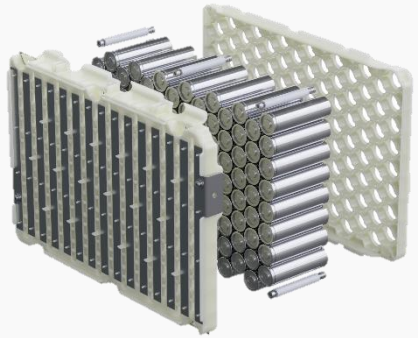
[1]Global Warming Potential (GWP) [kg CO_2 eq.] from [https://plasticseurope.org/sustainability/circularity/life-cycle-thinking/eco-profiles-set/ Based on cradle to gate figures (from crude oil extraction to granules or resin at plant), last review Aug. 8th, 2023]

3 in1 Polycarbonates For Batteries & Electronics

Precise & low warpage materials for each applications

Cylindrical cells

Cell holders, busbar holders, cell contacting systems

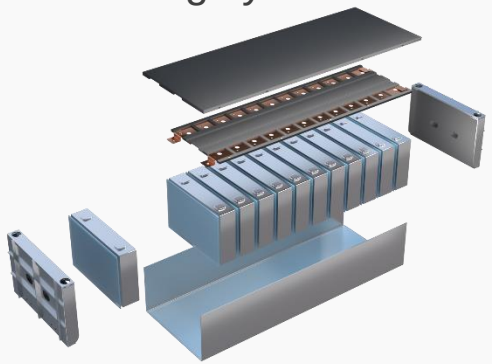


Bayblend® FR3010
Bayblend® FR3042
Bayblend® FR3080 EV
Bayblend® FR3040 EV for UV-curing

Makrolon® 6555 for UV-curing
Makrolon® TC

Prismatic cells

Insulation plate, top/bottom plates, end plates, cell contacting systems

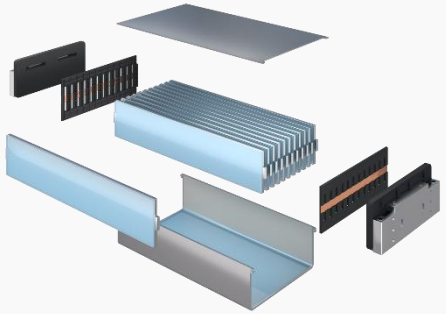


Bayblend® FR3010
Bayblend®FR3015 CTI
Bayblend® FR3020
Bayblend® FR3060 EV

Makrolon® FR6005 HF

Pouch cells

Cell frames, top/bottom plates, busbar carriers



Independent of cell type

Electronics housings, large-size part

Source: Alta Motors 2018

Source: BMZ GmbH 2018

Bayblend® FR3010 & T85X
Bayblend® FR3015 CTI

Makrolon® 6165X RE[1,2]
Makrolon® 6487, FR6019 CTI

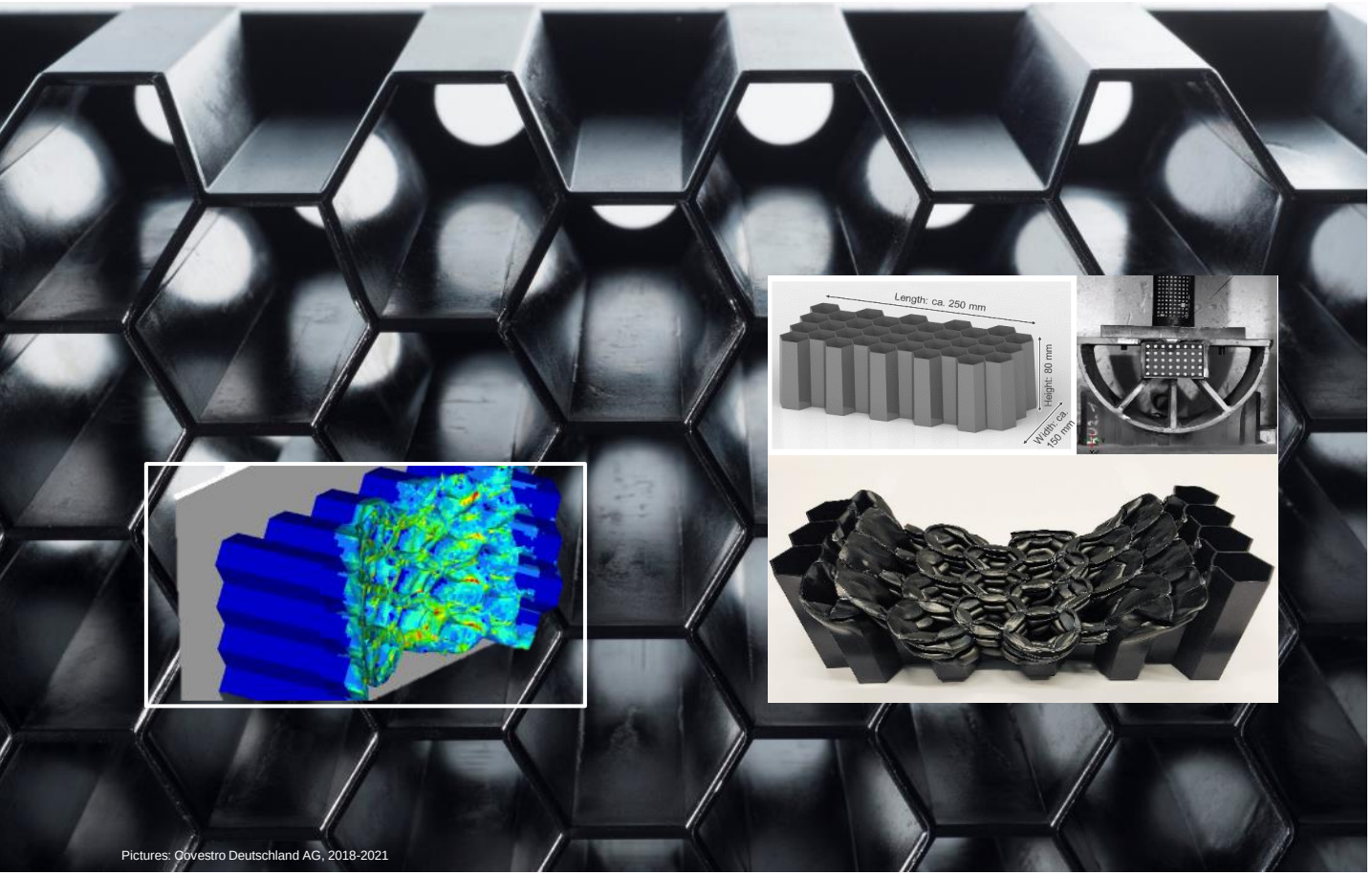
Makroblend® UT6007
Makroblend® KU2-7912/4

[1]Grades with recyclable content and renewable attributed bio-circular feedstock available
[2]Using LFTD process - Passes burning and abuse tests (GB/T 31467.3)
Picture(s): Covestro, 2020-2021

More information
Covestro Solution Center

Crash Absorber Made By Makroblend® KU2-7912/4

Highest crash protection at the lowest cost and weight

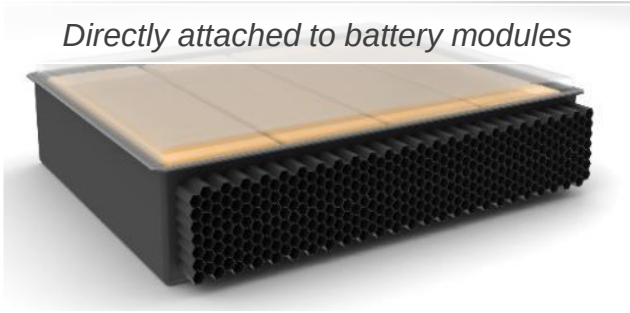


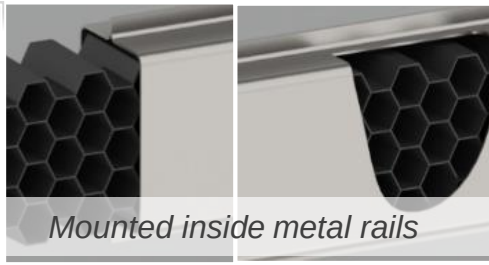
Pictures: Covestro Deutschland AG, 2018-2021

Makroblend® KU2-7912/4

Crash Element

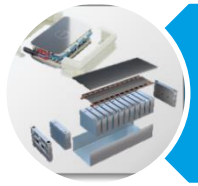
- Longitudinal loaded honeycomb tubes
- Tested by dynamic pole impact simulating a side impact crash
- PC+PBT blend, unreinforced, ultra-tough & ductile and good adhesion to PUR crash foams
- For Li-Ion battery protecting crash elements & protection covers





Electrifying Mobility with Premium Polycarbonates

Agenda



3in1 Polycarbonates

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- Precise molding with low warpage materials
- Stable mechanical properties over temperature
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Extended lifetime

Makrolon® TC for heat dissipation

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Thermally Conductive Makrolon® TC Grades

A New Category to the Existing Makrolon® Portfolio

Makrolon® TC629

Thermal conductivity
- in plane: 15 W/mK
- through plane: 1.2 W/mK

ASTM E 1461-01, 23°C

- High thermal conductivity
- Electrically conductive
- High softening temperature

Makrolon® TC621

Thermal conductivity
- in plane: 16 W/mK
- through plane: 1.4 W/mK

ASTM E 1461-01, 23°C

Makrolon® TC421

Thermal conductivity
- in plane: 8 W/mK
- through plane: 0.9 W/mK

ASTM E 1461-01, 23°C

- Customized thermal conductivity
- Electrically conductive
- Easy to process

TC110

TC210

TP5176*
UL94V-0, 2.0 mm colorable

Thermal conductivities
- in plane: 0.8-1.4 W/mK
- through plane: 0.3 W/mK

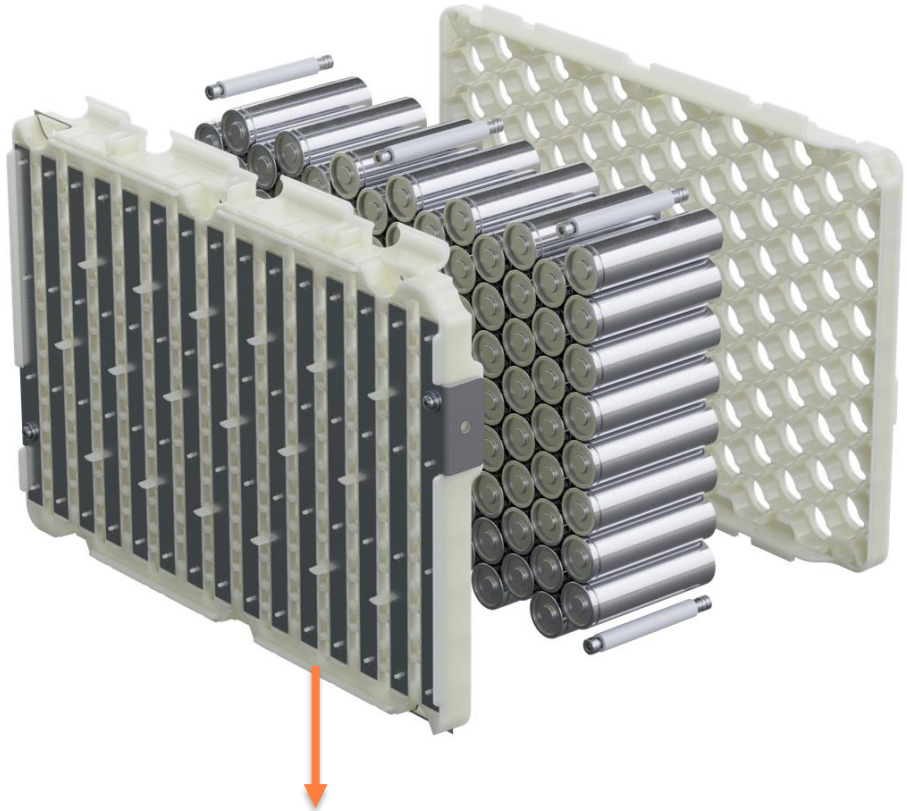
ASTM E 1461-01, 23°C

- Moderate thermal conductivity
- Electrically insulating, easy to process

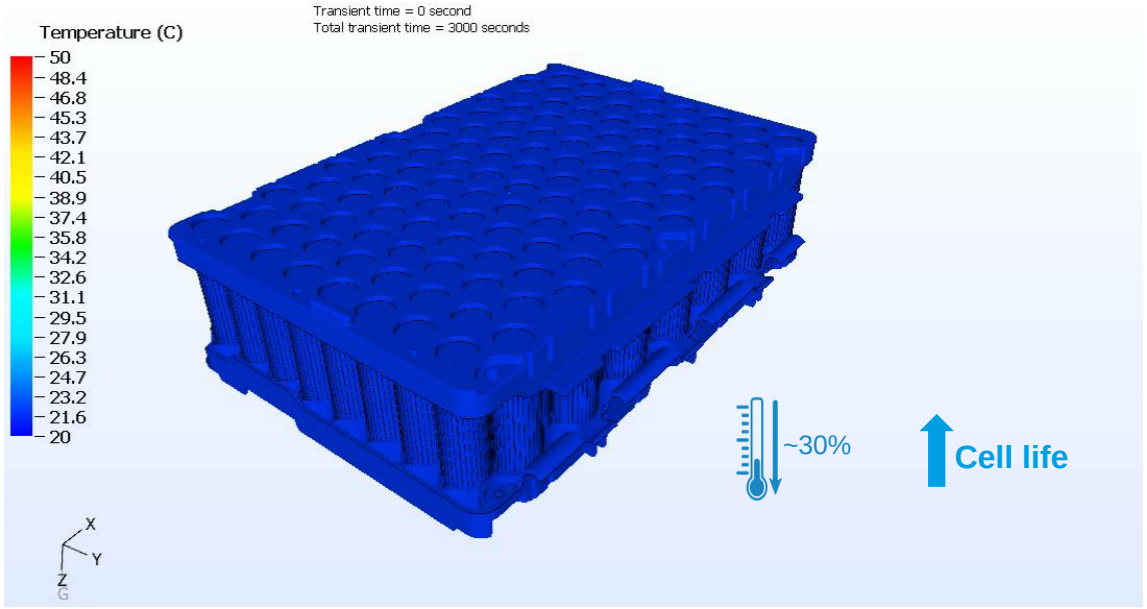
* Trial product, preliminary properties

Extended Lifetime by Reducing Cell Temperatures

Reduction of hot spots & thermal gradient after charging / discharging



Cell holder made of white Makrolon® TC



More information
Covestro
Solution Center

Thermal Simulation of Different TC Grades

Makrolon® TC629 fits to cooling requirements with 10W thermal power

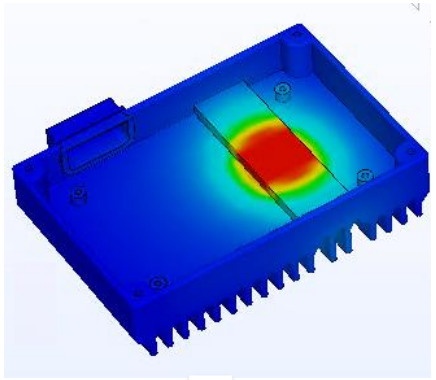
Material: **Makrolon® TC110 FR**

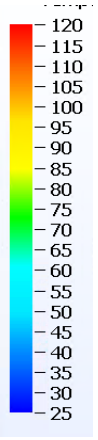
Thermal conductivity
(in- / through plane)

Thermal output: **10 W**

Resulting T_{max}: **297 °C**

Result: **Failed**





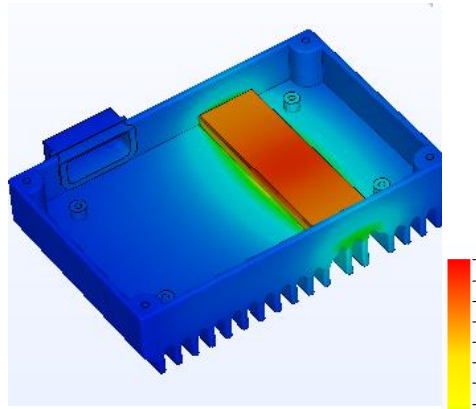
Material: **Makrolon® TC110 FR**
+ Al heat spreader

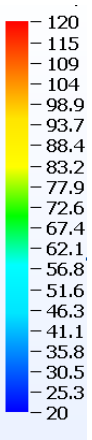
Thermal conductivity
(in- / through plane)

Thermal output: **10 W**

Resulting T_{max}**: 115 °C**

Result: **Passed**





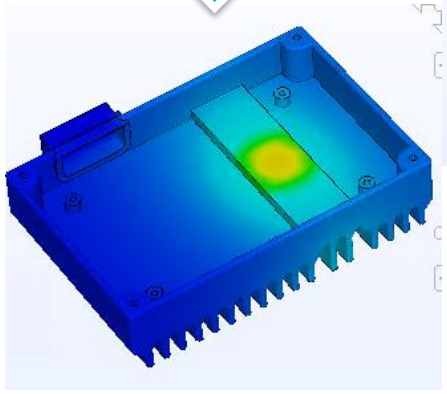
Material: **Makrolon® TC629**

Thermal conductivity
(in- / through plane)

Thermal output: **10 W**

Resulting T_{max}: **94 °C**

Result: **Passed**



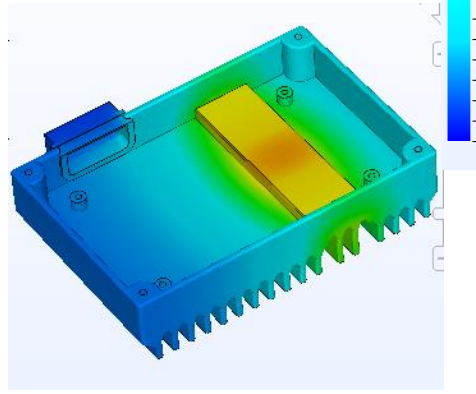
Material: **Makrolon® TC629**
+ Al heat spreader

Thermal conductivity
(in- / through plane)

Thermal output: **20 W**

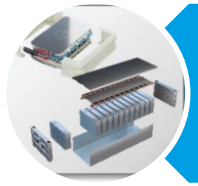
Resulting T_{max}: **103 °C**

Result: **Passed**



Electrifying Mobility with Premium Polycarbonates

Agenda



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WE COMBINED

- UL94 V-0 FLAME RETARDANCE &
- CTI 600 V ELECTRICAL CREEPAGE RESISTANCE

WITH THE

- LOW PREDICTABLE SHRINKAGE & WARPAGE, AS WELL AS DIMENSIONALLY STABILITY
- EXCELLENT DUCTILITY
- STABLE MECHANICAL & ELECTRICAL PROPERTIES OVER TEMPERATURE

OF AMORPHOUS POLYCARBONATES !

CTI/FR Polycarbonates For High Voltage Applications

Combining the best of two material worlds

At a glance

- Amorphous, dimensional stable (CTI / FR) materials for usage in Li-Ion batteries, high voltage components in the electric powertrain and the electrics / electronics industry
- CTI 600V, UL94 V-0
- Isotropic shrinkage, low warpage
- UL Yellow Cards available

Technical information available in the Covestro Solution Center:

- Technical datasheets:
  Bayblend® FR3015 CTI, Yellow Card
  Makrolon® FR6019 CTI, Yellow Card
- More information:
  CTI polycarbonates story

Covestro
Solution Center

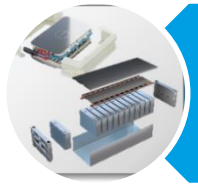
High voltage device
(exemplary representation)

	Standard	Bayblend® FR3015 CTI	Makrolon® FR6019 CTI
CTI[1]	IEC60112, Solution A	**600 V**	**600 V**
Burning behavior	UL94	**V-0 (1,5 mm)**	**V-0 (1,5 mm)**
Vicat	ISO 306	**120 °C**	**131 °C**
Molding shrinkage	ISO 294-4 (∥ & ⊥)	**0,5 – 0,6 %**	**0,5 – 0,6 %**
Electrical strength	IEC 60243-1 Test condition: 1 mm	**36 kV/mm**	**31 kV/mm**
Volume resistivity	IEC 62631-3-1	**$4 \cdot 10^{16}$ Ωm**	**$4 \cdot 10^{17}$ Ωm**
Colors[2]		**Natural, grey, white, black, orange**	**Natural, grey, white black, orange**

[1] The CTI value according to IEC60112 is the highest voltage at which no specimen fails during testing on five samples, each after the application of 50 drops.
[2] Yellow Card recognition, for colors not mentioned on the Yellow Card please contact Covestro
NOTE: Covestro data & measurements not guaranteed by this presentation. Please refer to the official Covestro material data sheets.

Electrifying Mobility with Premium Polycarbonates

Agenda



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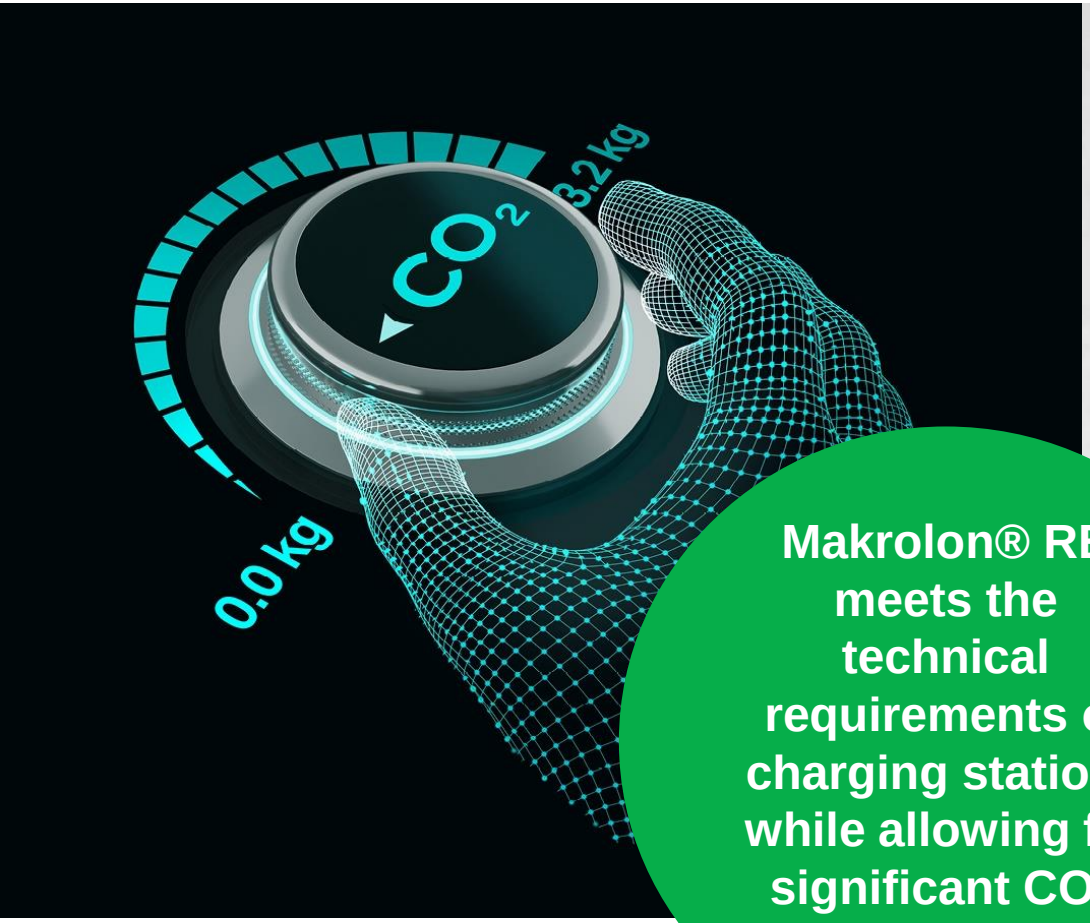
Covestro aims to become climate neutral!

Driving the transition to electromobility

Our RE solutions enable low-carbon-footprint EV chargers



Makrolon® RE meets the technical requirements of charging stations while allowing for significant CO2 emission savings

EVBox Livo operates in temperatures between -30 and +50°C and has built-in heat managemen

Makrolon® RE is a plastic replacement that consists of raw material derived from bio-waste and is mostly produced with renewable electricity, reducing the overall carbon footprint of EVBox Livo by 70 percent.

Enhanced sustainability

We replaced the majority of plastics in EVBox Livo with Makrolon® RE, a durable and sustainable alternative to conventional plastic, that helps you reduce your carbon footprint.

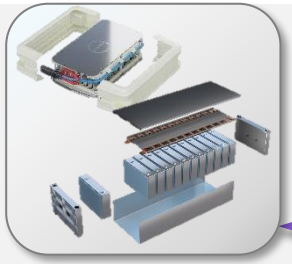
RE series:
renewable attributed solutions

for companies requiring high performance engineering plastics , available today in large quantities, with high bio-circular share and
with very low CO2e footprint at highest quality standards

Electrifying mobility with polycarbonates

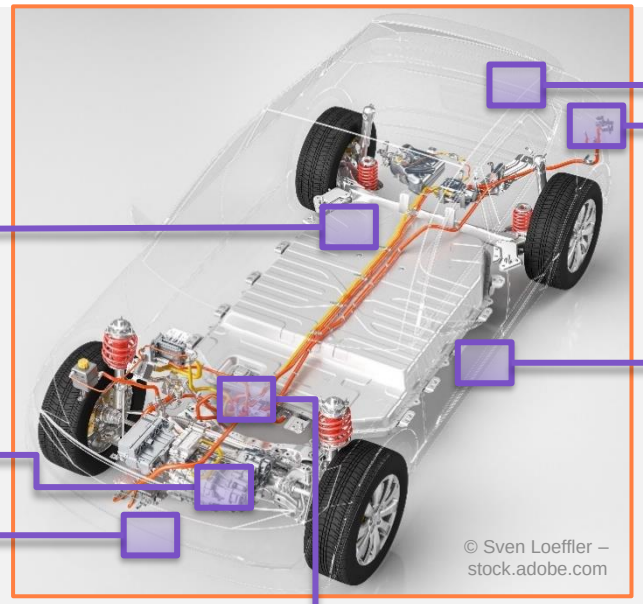
Curious about what else is possible? Talk to us!

Battery packaging
Bayblend® FR, Makrolon®
Makrolon® TC, Bayblend® FR CTI
Dimensional stable and flame retardant
Module housings, covers, cell carriers



Power electronics
Makrolon® FR CTI, Makrolon® TC
Bayblend® FR CTI
Low warpage, precision molding
FR grades available
high temperature stability w/o GF
Housings, brackets, heat sinks…

Sensors
Makrolon® AX ST
Excellent sensor transparency
LiDAR covers
Bayblend®, Makroblend®
Excellent and homogeneous dielectric properties (DK & Df)
RADAR housings



Control units
Bayblend® FR,
Makrolon® (TC)
Dimensional stable, heat resistant and ductile
Electronic housings, covers, plugs and sockets

V2X connectivity
Makrolon®, Bayblend®,
Makroblend®
Excellent signal transmission due to amorphous structure
5G antenna integration...

Charging units
Makrolon®, Bayblend® FR
Makrolon® & Bayblend® FR CTI
Excellent low temperature ductility, design freedom, high durability
Displays, charging status indicators, housings…

Crash absorbers
Makroblend®
Excellent low temperature ductility for energy absorbing components
Protection of batteries, power electronics and others

Disclaimer: The shown design is only intended to show ideas. Third parties may e.g., have rights to designs or technical property rights such as patents that must be considered. Appropriate FTO considerations would therefore have to be carried out before the implementation of corresponding concepts.

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Thank you

Contact

Steven Daelemans