



Advancing Physical Intelligence:

Polymer Materials for Robotics & Humanoid Systems

Topics



1

Introduction:

**Covestro's scale &
engineering plastics
portfolio**

2

Trends:

**Opportunities and
challenges amid the rise
of robots**

3

The Material Effect:

**Why Covestro & our
materials bridge
engineering, processing,
and design**



Covestro, Your Global Polymer Manufacturer of Choice



High-performance Solutions



Strong and global

€12.9 bn in sales

17,600 employees

46 production sites

Game-changing and beneficial

Polymer materials
of superior quality

Across numerous
industry sectors

For global challenges



Innovative and sustainable

1,300 employees
in research and development

80 years of ideas
and inventions

Pioneer of the
circular economy

Covestro Engineering Plastics

First polycarbonate manufacturer
with global HQ in China.

Leader of polycarbonate solutions
with global presence:

- 7 Production sites
- 3 Innovation centers
- 6 CMF research centers



Electrical & Electronics



Healthcare

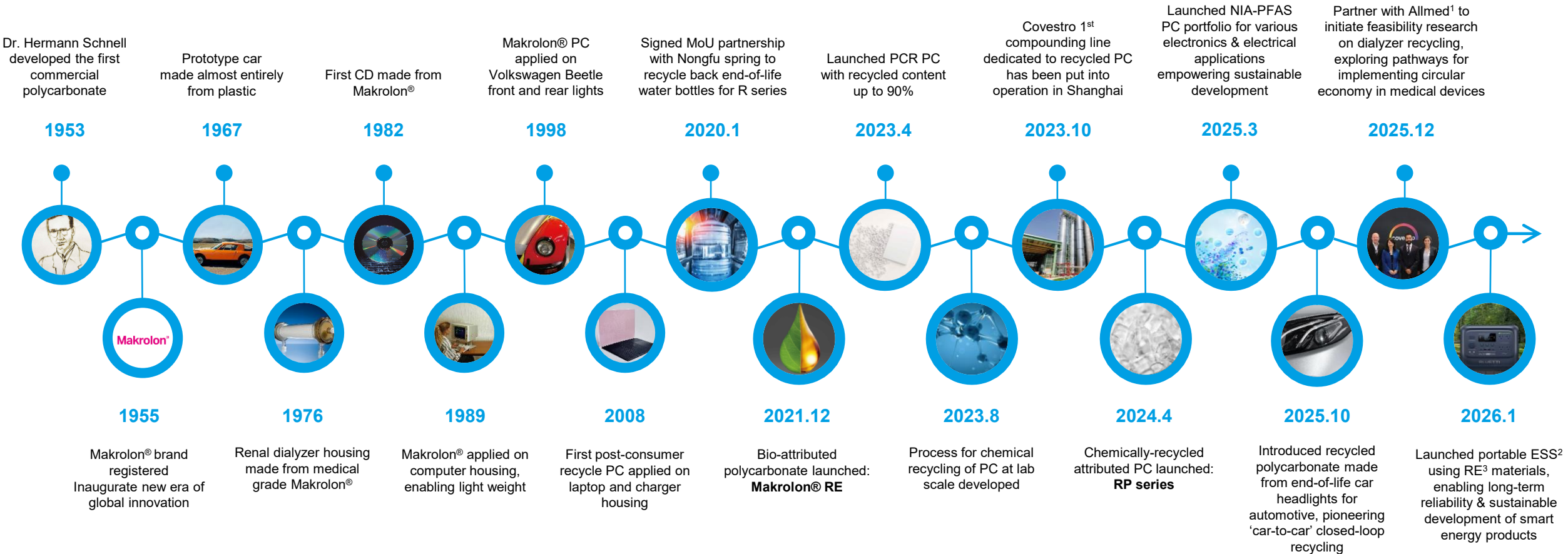


Mobility



Innovation and Inheritance of Engineering Plastics

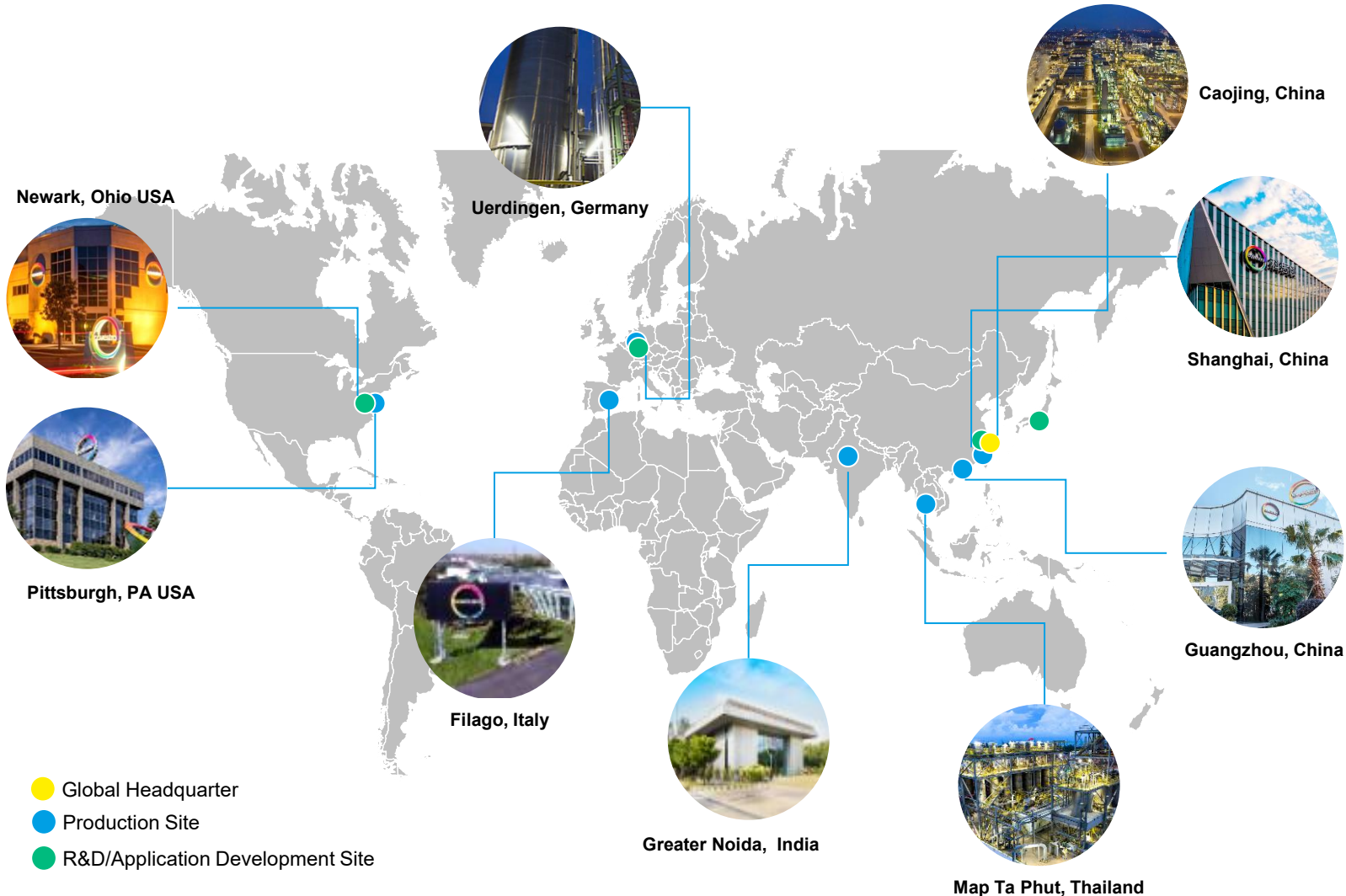
70 years of innovation with customers in mind since PC invented



31.08.2026

1 - Allmed: an international blood purification specialist
 2 - ESS: Energy Storage System
 3 - RE: bio-circular attributed polycarbonate

Engineering Plastics Global Presence



**The Only
Truly Global
& Innovative
Polycarbonate
Player**

Regional HQs in Pittsburgh, PA USA, Leverkusen, Germany, & Shanghai, CN

Solutions for Global Mega Trends



Infrastructure



5G Networks



Satellite Communications



New energy
/ Photovoltaic



Security
& Protection



Charging piles
/ Charging guns



Intelligent
Logistics

Consumer Electronics



Laptop
& Computing



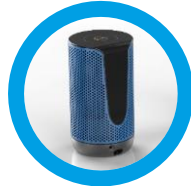
Wi-Fi Connection



Gaming



Drone



Smart Appliances



Wearable Devices

Emerging Industry



Robotics



Data Center



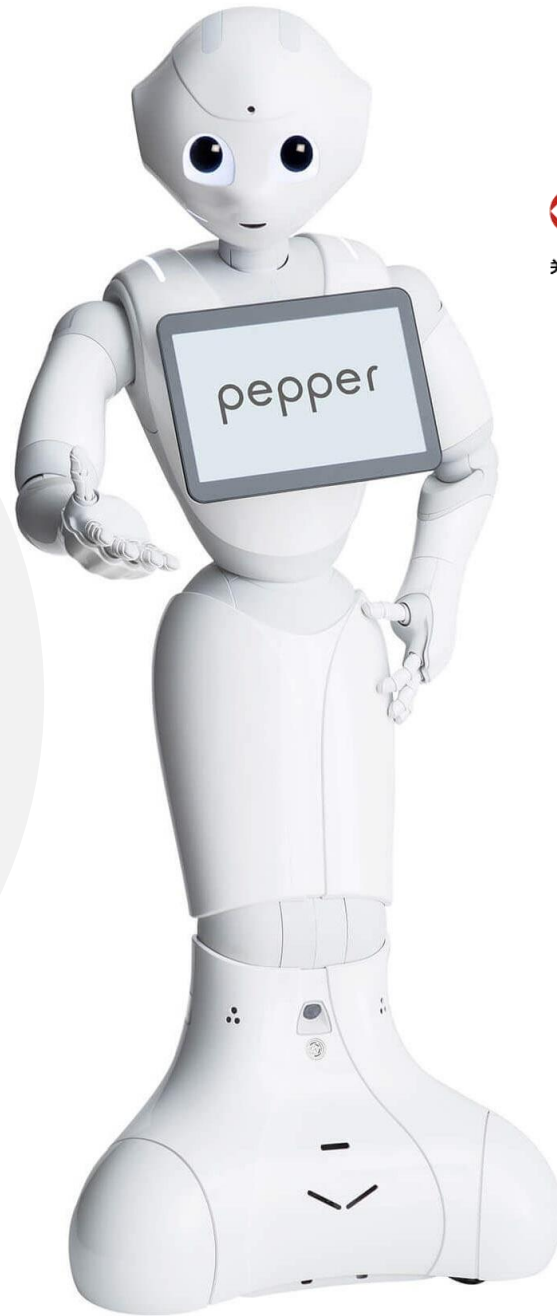
Semi-conductor

Supporting a
comprehensive
set of key
industries,
covering
diverse
applications

Pepper & Pudu

FR PC/ABS Offering Outstanding Performance

- ✓ V0 @ 1.1-1.5mm flame retardancy
- ✓ Low-temperature impact resistance at -10 °C
- ✓ Balanced impact & chemical resistance
- ✓ Superior colorability & elegant high-gloss white



JP EN 中(简/繁) 联系我们

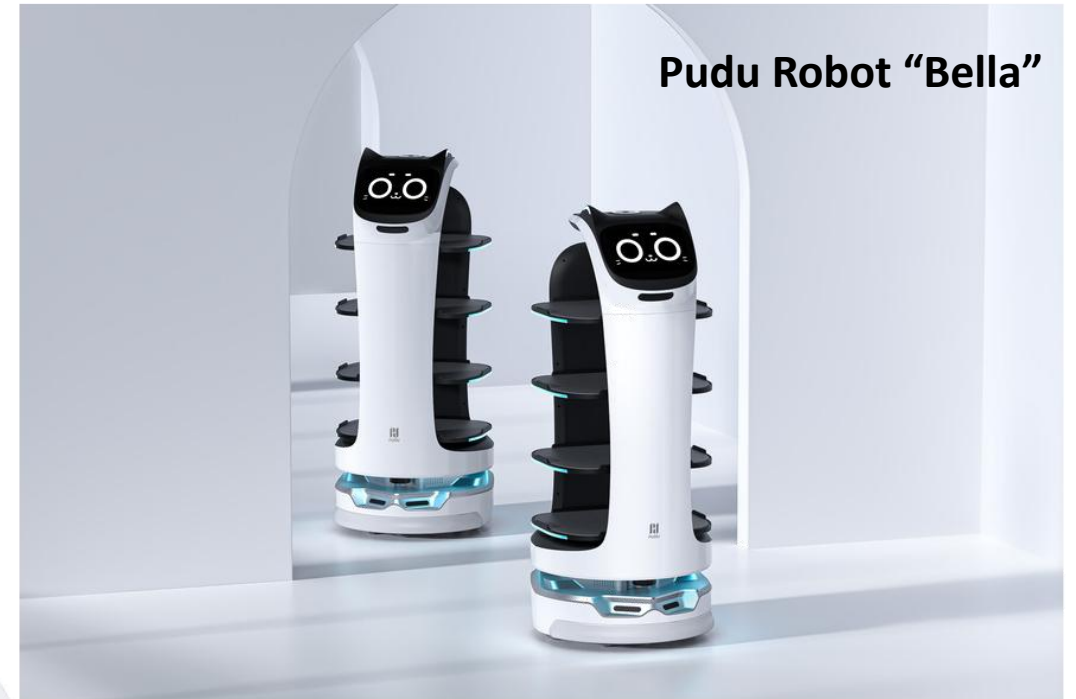
GOOD DESIGN AWARD

[关于GDA](#) [历届获奖作品](#) [参评方法](#) [获奖作品推广](#) [历届信息](#)

2022 [Year awarded](#) [Special Award](#) [Display detailed search](#)

GOOD DESIGN AWARD

[Previous page](#) [Back to List](#)



Enabling Leadership in the Physical AI Era

When polymer innovation meets humanoid revolution,

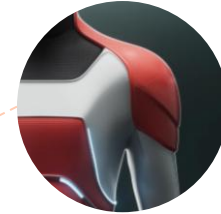
We provide **comprehensive material solutions** for your robotics ecosystem.



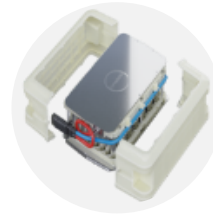
Sensors, cameras, lens & antenna box
Polycarbonate (PC)



Robotic housing & joints
Multipurpose adhesive and coating solutions



Battery packs
Polyurethane (PU) and Polycarbonate (PC)



E-skin & Printed electronics solutions
Specialty Films



Optical fiber and wire solutions
Optical fiber coatings (CA)
Thermoplastic polyurethane (TPU)



Robotic feet
Thermoplastic polyurethane (TPU) & Casting polyurethane (ELA)



Covestro Humanoid Robotic PC Solutions



Lightweight & Impact-Resistant, Built for Strength

- Enhances robot agility and battery life
- Protects critical components
- High flow for thin wall claddings

Covestro Material Solutions

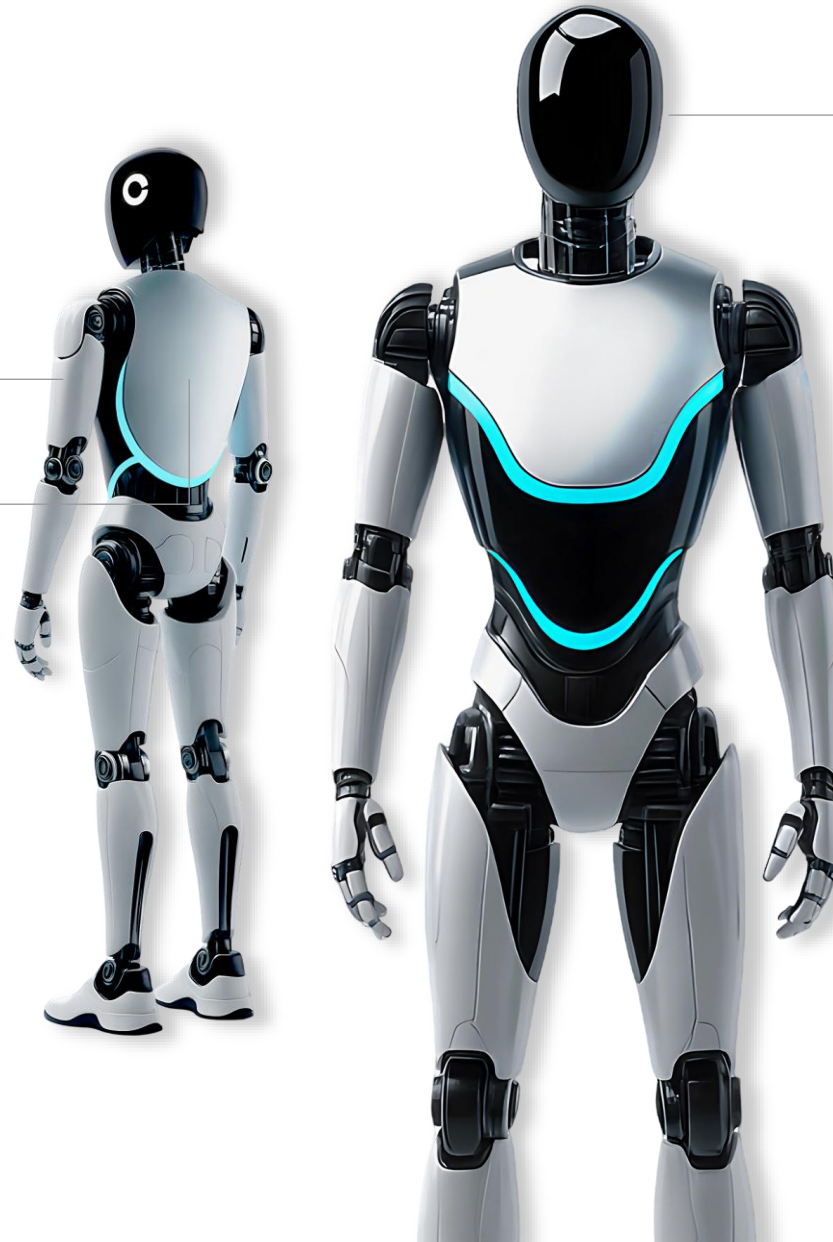
- Apec® XT
- Bayblend® FR3010HI / FR3502 / FR3210TV / FR3008HR
- Makrolon® FR6040HR

Efficient Thermal Management, Safeguarding Battery and Brains

- **Battery system:** Excellent FR and high RTI ensure long-term stable operation in high-temperature environments
- **Chip/electronic control system:** High thermal conductivity, low dielectric constant (Dk) to ensure signal integrity, and low CLTE

Covestro Material Solution

- Makrolon® TC
- CTI grades



Sensor Transparency and Optical Quality for Vision & Planning

- **Optical transparency:** Provides a clear view for visible light cameras with high impact
- **High near-IR transmittance:** Ensures undistorted signal transmission for infrared and other sensors
- **Flame retardancy:** Meets overall device electrical safety standards

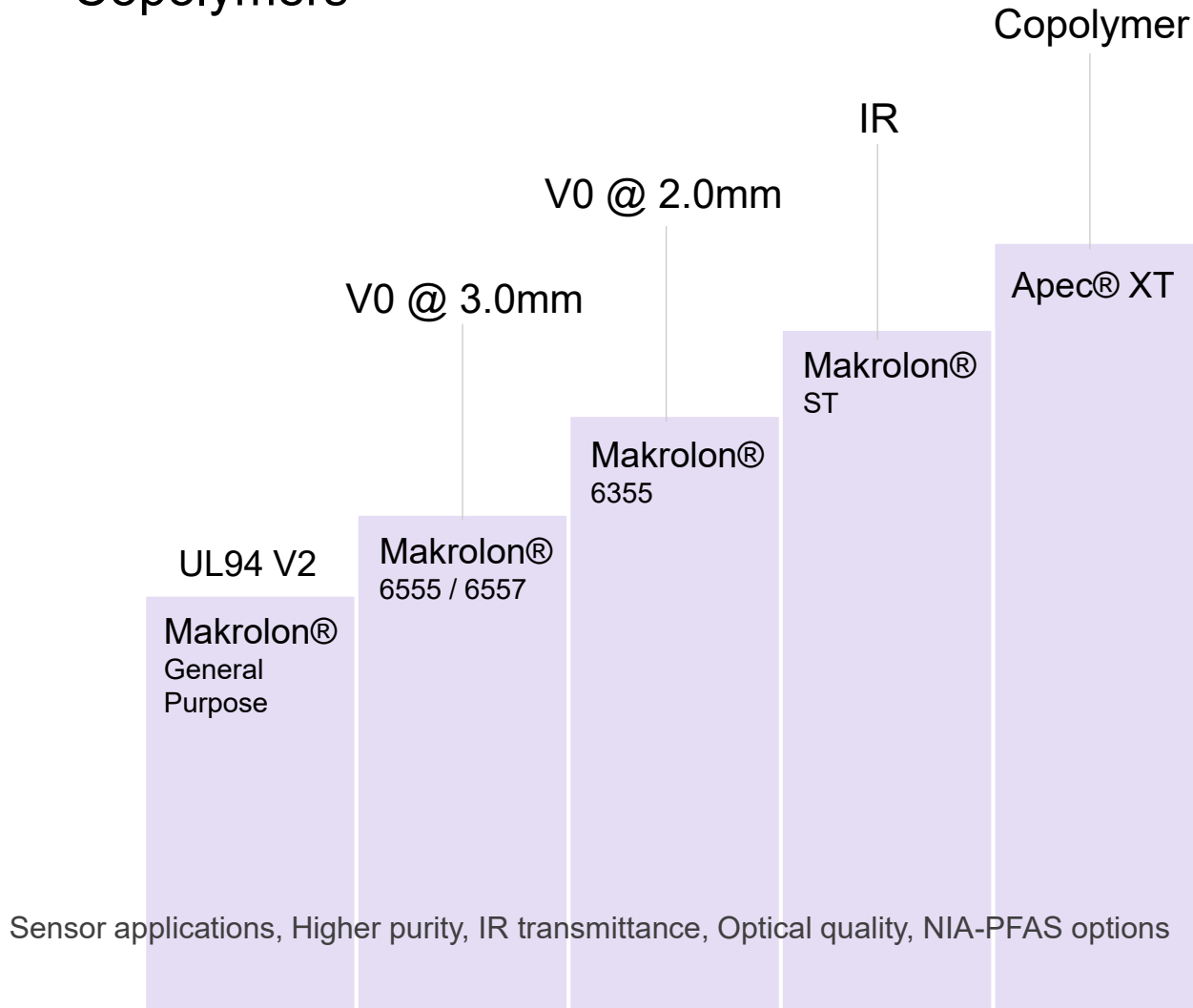
Covestro Material Solution

- Makrolon® ST
- Apec® XT
- Makrolon® transparent



Diverse Portfolio for Robot Head

HB-V0 Flame-Retardant, High Gloss Black,
Transparent & IR-Transmitting, Standard PC &
Copolymers



Unique IR Transparency Meets High-Gloss “Piano Black” Aesthetics

Makrolon® and Apec® series



High-gloss “piano black” finish with controlled NIR high transmittance



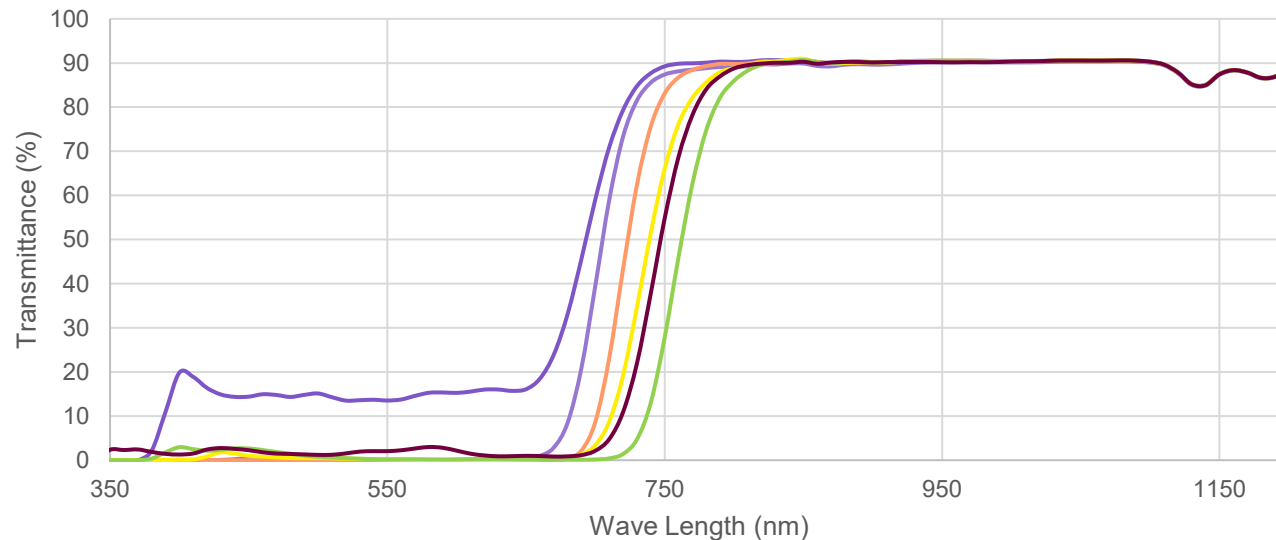
Good ductility



Enhanced lightfastness for improved fade resistance



Suitable for various sensor applications



INTERNAL

Next-generation Polycarbonate Copolymers for Demanding Applications

Apec[®] XT



Outstanding impact resistance, maintaining high ductility to **-50°C**



Enhanced chemical resistance to oils and sunscreens, etc.



Inherent flame-retardancy



Easy to process and enhanced demolding



Superior weather & UV resistance



Full Range of Materials for Robot and Charging Station Enclosures

LiDAR Covers

Covestro Material Solutions
Makrolon® Ai2695 ST

Color: Piano black

Advantages:

- Block visible light
- Infrared light transparency (89% IR transmittance at 2 mm / 905 nm)

Battery Pack Enclosures

Covestro Material Solutions
Bayblend® FR3040W

Color: Black

Advantages:

- Ultra-high flow for thin-wall designs
- Excellent flame-retardancy
- V0 @ 0.75mm



Robot Housings & Claddings

Covestro Material Solutions
Bayblend® FR3010HI

Color: Customized per requirements

Advantages:

- Ultra-high flowability and excellent flame-retardancy
- Impact-resistance and drop-resistance
- Excellent structural rigidity and dimensional stability, easy to assemble

Bayblend® FR3502
Enhanced low-temperature impact-resistance

Bayblend® FR3210TV
Enhanced flowability

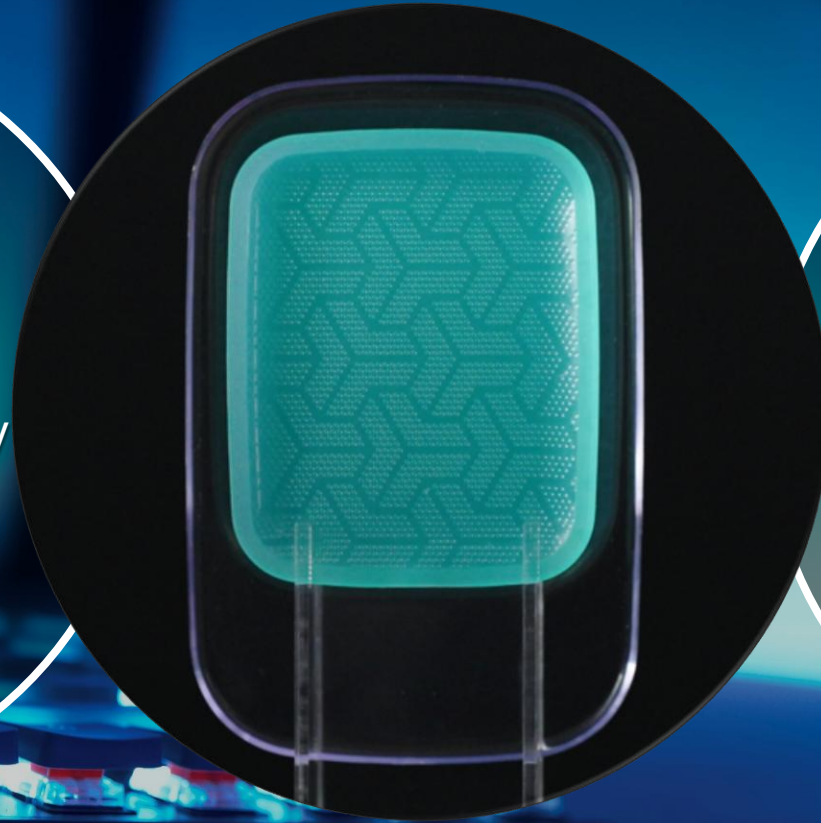
Bayblend® FR3008HR
Enhanced hydrolysis resistance

Makrolon® Transparent flame-retardant solution

Transparent design: Creating product functionality, aesthetics and cool lighting effects

Transparent

Excellent flame-retardancy
UL94 V0 @ 1.5–2.0 mm



High Stiffness & Translucent

Glass-fiber reinforced
Excellent flame-retardancy
UL94 V0 @ 1.0-1.5mm

Transparent FR Products – Unfilled



Performance	Test Condition	Units	Traditional FR Polycarbonate	New! Makrolon® 6355	New! Makrolon® 6957
FR Rating UL94	V0	mm	V0 @ 3.0 mm	V0 @ 2.0 mm	V0 @ 1.5 mm
Flow / MVR	300 °C/ 1.2 kg	cm³/10 min	++	++	++
Impact Resistance	23 °C; 3 mm	kJ/m²	+++	+++	++
Heat Resistance	50 N; 50 °C/h	°C	+++	++++	+++
Light Transmittance	1.0 mm	%	+++	++++	+++
Light Transmittance	2.0 mm	%	+++	++++	+++

Technical Challenges to Maintain Optical Quality



The addition of flame retardants will cause light scattering and reduce transparency



Poor miscibility disrupts uniformity and light transmission, and creates haze

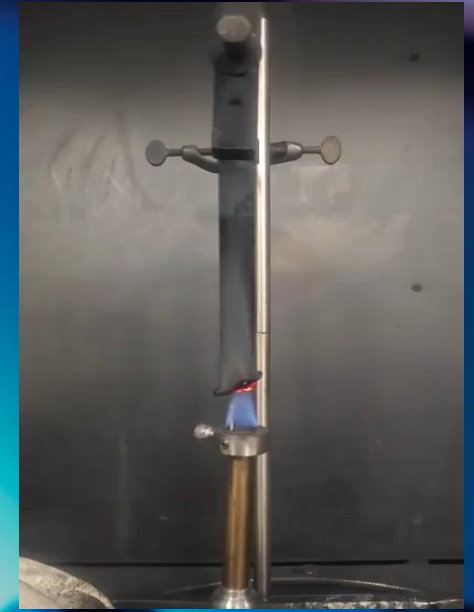


Changes in molecular structure or light absorption/scattering can reduce transparency

Flammability Test Comparison (UL Standard)



Traditional PC
V0 @ 3.0mm



Makrolon 6957
V0 @ 1.5mm

Glass-Fiber Reinforced High Translucency Solution: High Stiffness and Excellent Flame Retardancy



Performance	Test Condition	Units	^{New!} Makrolon® GF9024	^{New!} Makrolon® GF Updated Version
FR Rating UL94	V0	mm	V0 @ 1.5 mm	V0 @ 1.0 mm
Flow / MVR	260 °C/ 5 kg	cm³/10 min	++	++
Impact Resistance	23 °C; 3 mm	kJ/m²	++	++
Heat Resistance	50 N; 50 °C/h	°C	+++	+++
Stiffness	1 mm/min	GPa	++	+++
Light Transmittance	1.0 mm	%	+++	++
Light Transmittance	2.0 mm	%	+++	++
NIA-PFAS*	UL746G		n/a	Yes, sample ready

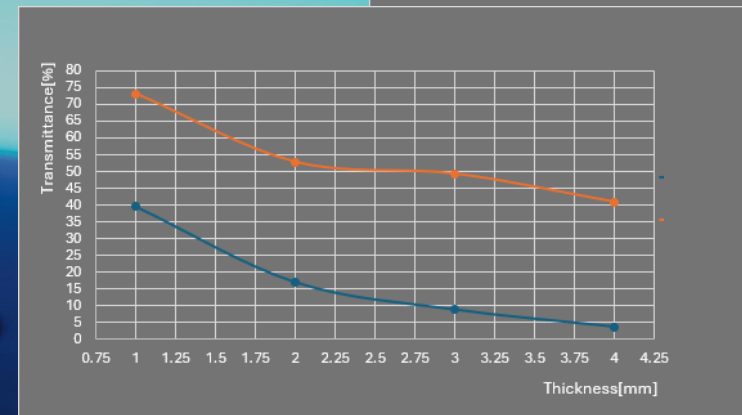
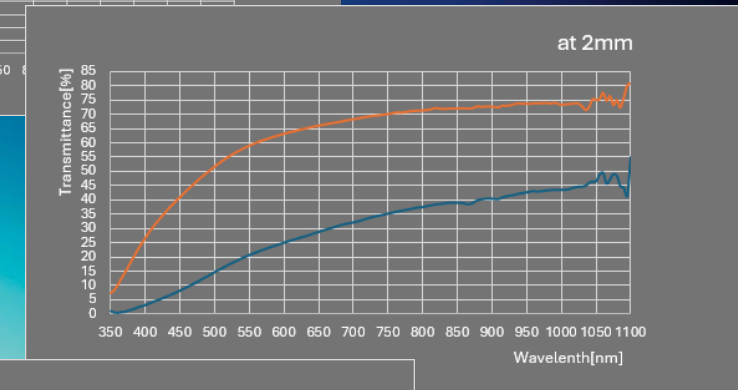
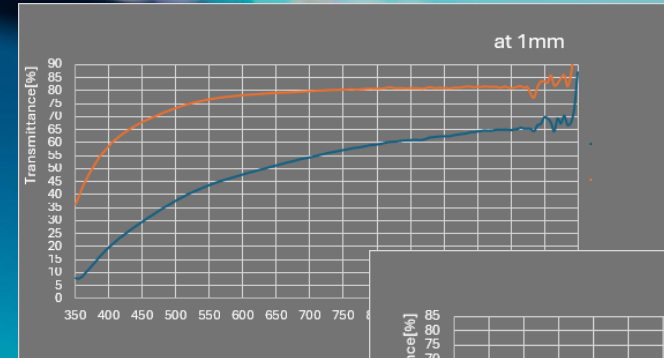
*NIA stands for non intentionally added PFAS

Side by Side Visual – more light output



**Makrolon Glass-Fiber
Reinforced High Translucency
Solution**

Traditional GF FR PC



Next-Gen Thermal Management: Powering the AI Era

Makrolon® TC

-  High thermal conductivity
-  RF signal transmittance and stability
-  More compact and lighter than aluminum heat sinks
-  Moisture- and dust-resistant barrier, with optional vibration protection
-  Low injection pressure to protect PCBs
-  Greater design freedom, reduced complexity and assembly costs via injection molding



Igloo: Smarter Thermal Management for Electronics

Igloo applies Makrolon® TC over-molding on a Raspberry Pi CM4, injecting thermal material directly onto the PCB, and compares it with two alternative configurations:

No cooling system

VS

Makrolon® TC Over-molding

VS

Aluminum heatsink with TIM

- The over-molded PCB stays cooler and throttles performance less. Other boards reach 85 °C and throttle power to prevent overheating.
- Makrolon TC, despite lower thermal conductivity than aluminum, offers superior passive cooling thanks to **full coverage and higher emissivity**.



Lighter and Thinner

Significantly lighter and thinner, ideal for compact devices



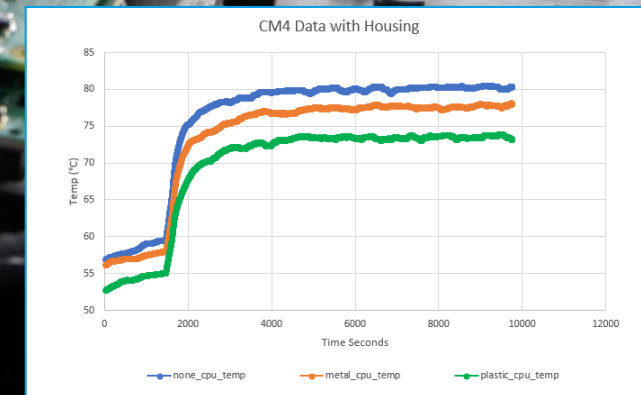
Durability

Resistant to moisture, dust, and shock



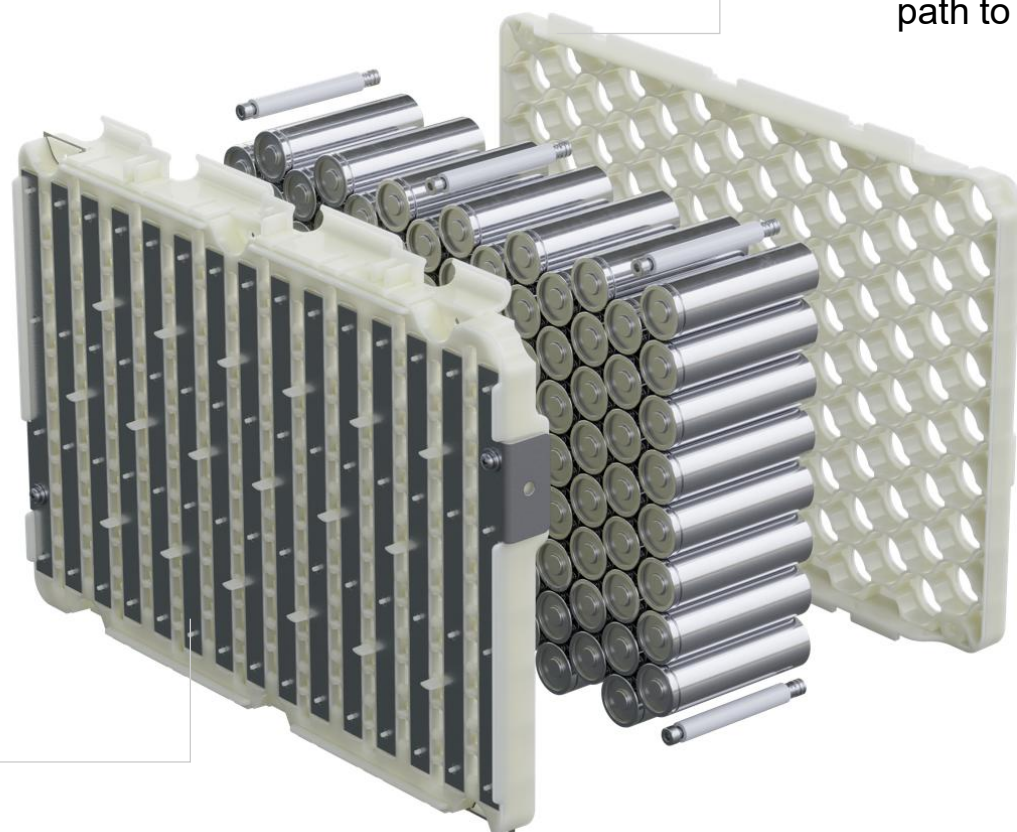
Enhanced Performance

Cooling components to enhance reliability and lifespan



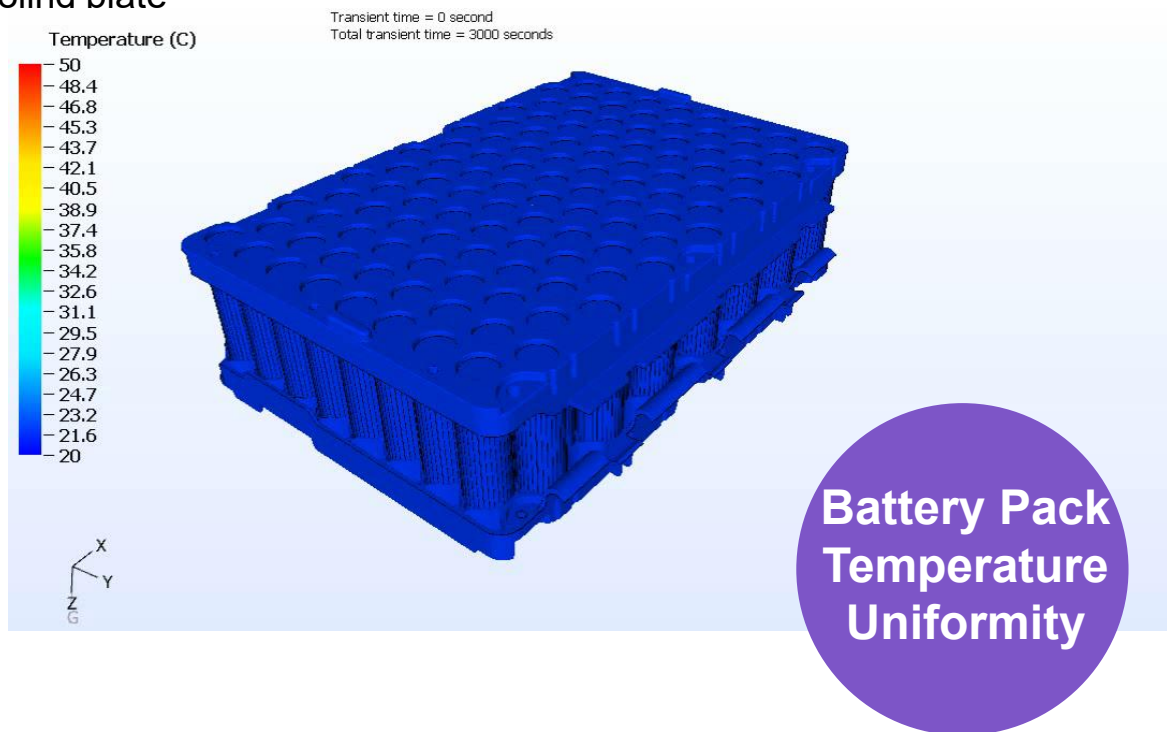
Safeguarding the Energy Core to Boost Battery Life and Performance

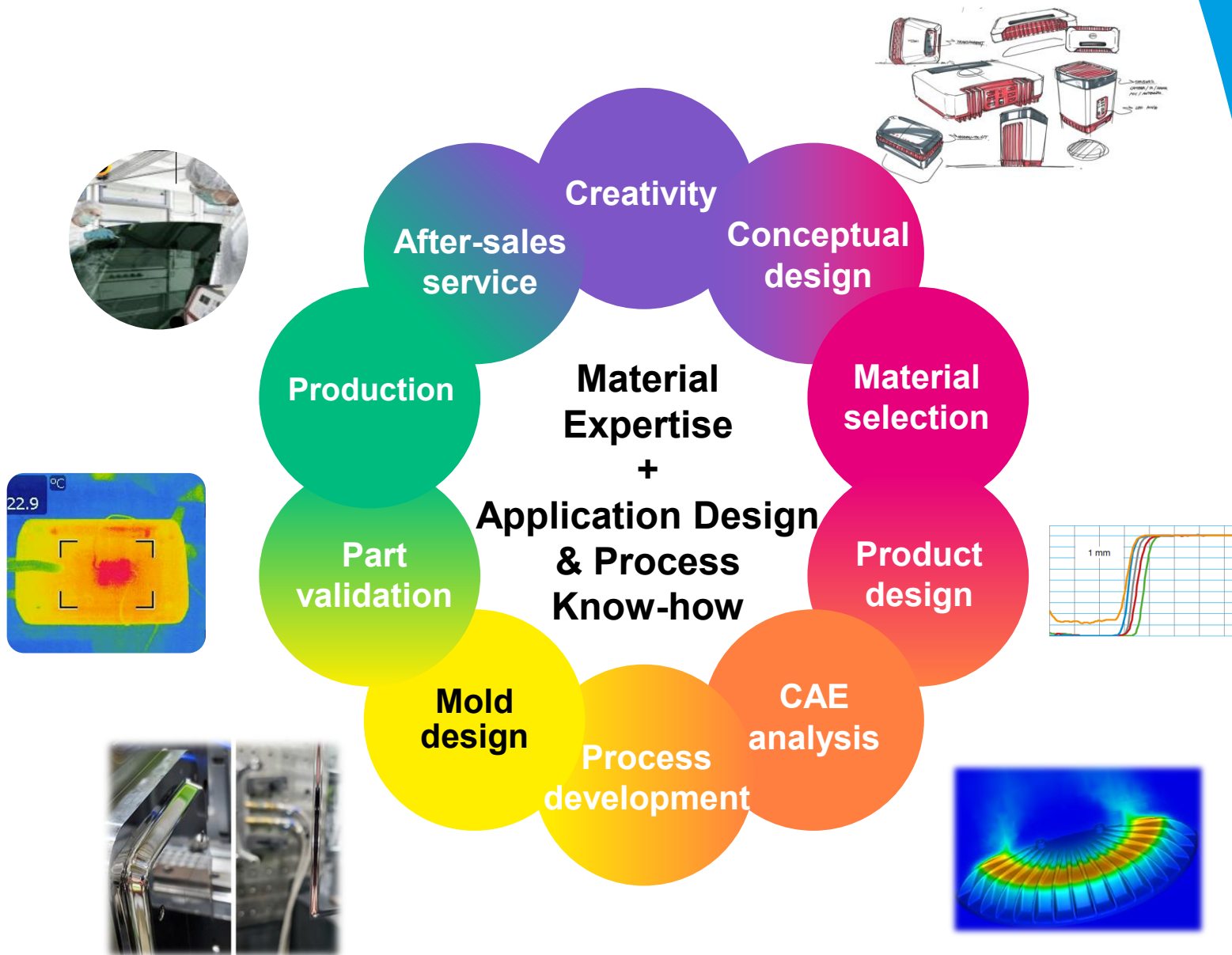
Makrolon® TC



Bottom Clamshell Bracket:
Provides the thermal conduction path to the cooling plate

Top Clamshell Bracket:
Designed to prevent contact between side panels and busbars, positioning and securely fixing the battery cells in place





Covestro,
Your Full-Service
Global Material Supplier
& Innovation Partner



Thank You



Contact us :

Bruce.Feng@covestro.com

Guoxin.Jiang@covestro.com

