



Makrofol® Makrolon®

Electric Vehicle (EV) faces of the future.

Designed to be functional.
Made to be remembered.
Crafted in Polycarbonate.



The synergy of innovation and elegance in Electric Vehicle (EV)

The automotive industry is currently undergoing a **significant transformation**. This is driven by the emergence of new technologies such as electric mobility and autonomous driving. It has also resulted in a shift in focus towards the development of body parts for electric vehicles that are not only more sustainable but also combine design freedom with an **ever-increasing level of functionality**. One area where this transformation is particularly evident is in the design of the vehicle's exterior, especially in the **frontend grille**.

Market requirements vs challenges

Existing requirements already include:

- Printed décor layers
- Safety aspects (pedestrian protection and overall crash behavior)
- Resistance to environmental influences
- Reduced installation space
- Low / controlled thermal expansion
- Reduced weight
- Cost efficiency

Enhanced functionality and design have added further challenges. For instance, there is a growing demand for transparent materials in the outer skin components to enable the transmission of sensor signals or illumination light.

Sensors like RADAR, LiDAR, IR, or VIS cameras are vital for autonomous driving. Achieving high surface qualities, material purity, and component precision are crucial for ensuring the long-term functionality of these sensors. On the outer surfaces, scratch-resistant coatings are necessary to ensure that sensor signals can pass through the cover undisturbed, even after years of use.



Frontend grille concept showcasing function and design integration through Film Insert Molding (FIM) technology – presented by Covestro at K'22 fair.

Engineering ingenuity enabled by polycarbonate

The EV transformation has resulted in a lot of movement in the pre-development area. **New opportunities for materials and manufacturing technologies** are opening up. The challenge at hand is to merge specific designs with partially hidden functions in exterior components. In consequence, outer parts in the area of the former radiator grille have undergone enormous changes in recent years. One "close to reality" example illustrating this trend has been showcased by Covestro at the K fairs in 2019 and, in a much more developed state, in 2022.

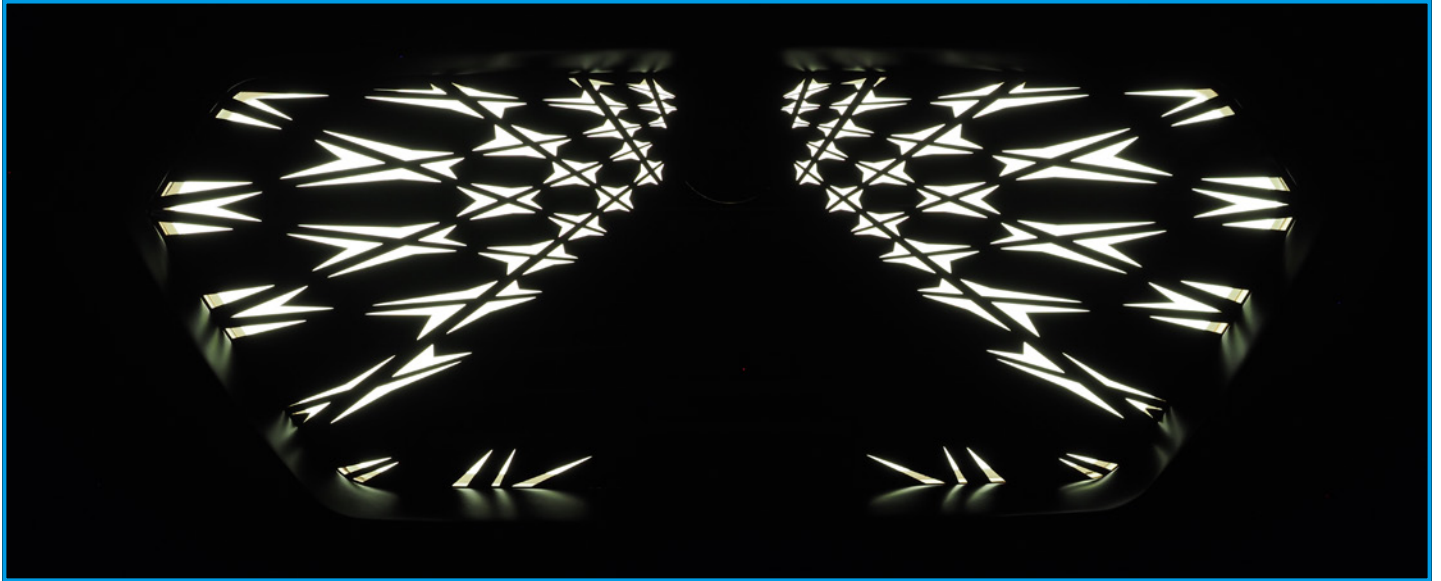
Another shift induced by the move towards EVs becomes evident, i. e. the lighting integration into surrounding components. This is driven by both, design considerations and the **relocation of individual lighting functions** from the headlight to other areas of the vehicle. The combination of intriguing design, lighting, and heating functions is featured in Covestro's latest frontend concept, as demonstrated (see pictures below).

Questions have been raised about the **testing standards and regulations** that must be met in the targeted vehicle exterior applications. For example, in the United States and beyond, the use of materials listed via the Automotive Manufacturers Equipment Compliance Agency, Inc. (AMECA) is expected.

This requirement touches a wide range of thermoplastics, coatings, and other raw materials used for lighting components. Now it becomes potentially **relevant to many new exterior body part concepts**. Covestro answers the call for AMECA compliant materials with our Makrofol® and Makrolon® polycarbonate portfolios.



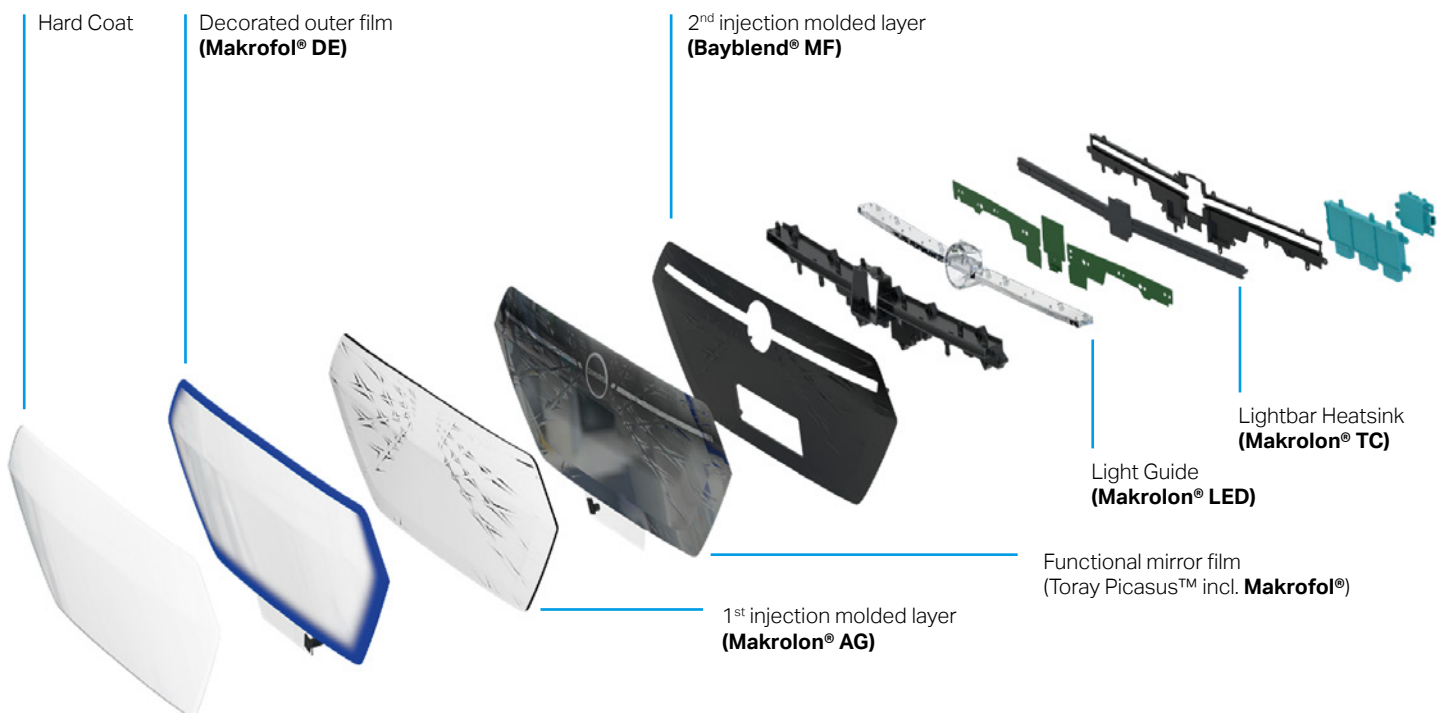
Integrated heating ensures reliable radar sensor function and display performance in harsh weather.



Lighting transforms into a full-area design feature with larger single and dual-part of frontend grille concepts.

Crafting future design through advanced-engineering materials

Developed in collaboration with industry leaders, this frontend grille exemplifies excellence in both aesthetics and functionality. The seamless outer surface of the grille features a pioneering black & metallic, **chrome-like body color appearance**. The design distinguishes itself from traditional metalized materials and incorporates true **3D décor elements** as well as **LED illumination systems**. The functionality includes **glowing edges** realized via In-Mold Electronics (IME), a **hidden-until-lit logo**, a **lightbar**, and a **display**.



Through **sensor integration**, a radar module is discreetly hidden behind a metal-free chrome-like film, allowing it to operate seamlessly without compromising the panel's visual appeal. The integration of electronics includes an **embedded heating-wire system** via film, ensuring the functionality of both the display and radar. Film Insert Molding (FIM) provides designers with the flexibility to explore various form factors and achieve desirable part-to-part variation.

Where materials meet expertise

Material selection is critical for the frontend grille design process. The material of choice must possess the essential properties required:

- Tailored range of transparency
- Scratch, UV light, and chemical resistance
- Sufficient toughness
- Adequate thermal expansion
- Glass-like surface quality
- Injection moldability
- Cost efficiency

However, the need for transparency significantly limits the range of material options. The demand for cost efficiency further narrows the list of potential materials down to PMMA and polycarbonate. Despite their similar properties, polycarbonate has emerged as the preferred choice due to its higher toughness on impact.

Covestro offers a one-stop-shop solution to our customers. We combine our strong application development expertise in the whole process chain of FIM. A small selection from our broad portfolio of polycarbonate resin and film products is given below.

All grades listed may be used in frontend grille and roof panel applications, including sensor covers, depending on the part requirements.

Film grade	Typical application	Description
Makrofol® DE 1-1 000000	Décor layers	Highly transparent / good formability
Makrofol® DE 1-4 000000	Décor layers	Translucent / improved printability on one side
Makrofol® DE 4-4 160021	Emblems, wire heaters	Translucent / improved printability on both sides
Makrofol® LM243 2-4 160025	Headlamps, lighting	Diffuser / defined transmission and half power angle
Makrofol® LM296 1-2 760150	Hidden-til-lit features	Dark tinted / 50% transmission
Makrofol® LM302 1-2 000000	Radome covers	Visually transparent / very fine matt surface
Makrofol® LM903 1-4 160008	Reflector layers	Opaque white
Makrofol® ST342 1-1 940002	LiDAR covers	Opaque black / IR transparent / easy forming
Makrofol® ST362 1-1 940006	LiDAR covers	Opaque black / IR transparent
Makrofol® UV244 1-1 000000	Wire heaters	Transparent / UV protected
Makrofol® UV503 1-4 000000	Décor layers with special requirements	Transparent / UV protected / AMECA-listed material

Resin series	Typical application	Description
Makrolon® AG Series	Frontend grilles, automotive glazing parts	Visually transparent / translucent. Available in tinted neutral density colors
Makrolon® AX Series	Black exterior trim parts, sensor cover, exterior panels with integrated sensors	Visually opaque. Available in sensor transparent (NIR) black colors
Bayblend® MF Series	Large exterior parts with high dimensional stability, 2 nd component for 2K parts	Reduced Coefficient of Thermal Expansion (CTE) for higher dimensional stability and optimized shrinkage behavior
Makrolon® LED Series	Lightguides, lenses and other optical components	High transparency and purity
Makrolon® TC Series	Heatsinks and thermally conductive housing applications	High thermal conductivity. Available as electrically insulating

Not finding what you are looking for? Mass balance, bio based, recycled? Please contact us. We will turn the future of mobility into reality.



Covestro Deutschland AG
Kaiser-Wilhelm-Allee 60
51373 Leverkusen
Germany

films.covestro.com
films@covestro.com

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¹ Please see the "Guidance on Use of Covestro Products in a Medical Application" document.

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