



Illuminating innovations: Transforming lighting technology with specialty films.

From digital speedometers to advanced light management in diverse applications.

Makrofol®

Makrofol® light management films

LEDs are transforming the world of lighting and offer new, exciting design possibilities. But LED sources also pose challenges when it comes to glare, hotspots, and light uniformity which often requires the use of diffusion lenses. As one of several globally recognized suppliers in medical, automotive, consumer electronics, and construction applications, Covestro also offers lighting solutions with **Makrofol®** translucent polycarbonate film.

Designed for [LED lighting](#), Makrofol® films provide a range of diffusion levels with optimized light transmission – delivering proven quality and performance. Makrofol® film features higher impact strength than glass or acrylic, and superior temperature resistance over acrylic. The excellent strength of polycarbonate allows you to use thinner films and still achieve the results you desire. In addition, Makrofol® films can be formed into a variety of shapes to satisfy your application and design needs. The films ultimately provide the technical design freedom to maximize your light design performance and maintain optimum aesthetics.

High-value, specialty films for a variety of lighting applications

Specialty **Makrofol® LM** films products from Covestro are tailor-made for a variety of lighting applications. From automotive interiors and exteriors to residential, commercial and industrial lighting use cases, transparent and translucent grades of Makrofol® can meet the unique needs of the situation.

Properties and benefits:

- **High heat resistance:** Tough and durable over a wide temperature range
- **Good optical and thermal properties:** Great for lighting products of all kinds
- **Highly versatile:** Multiple optical functions can fit the need of many applications
- **Fully transparent:** Allows for maximum design freedom
- **Customizable:** Unique solutions for specific applications available



Automotive lighting applications

For [automotive lighting](#) component manufacturers looking to fulfill automotive OEM design requirements for North American rear lighting applications, Covestro offers lightweight diffuser films made from polycarbonate.

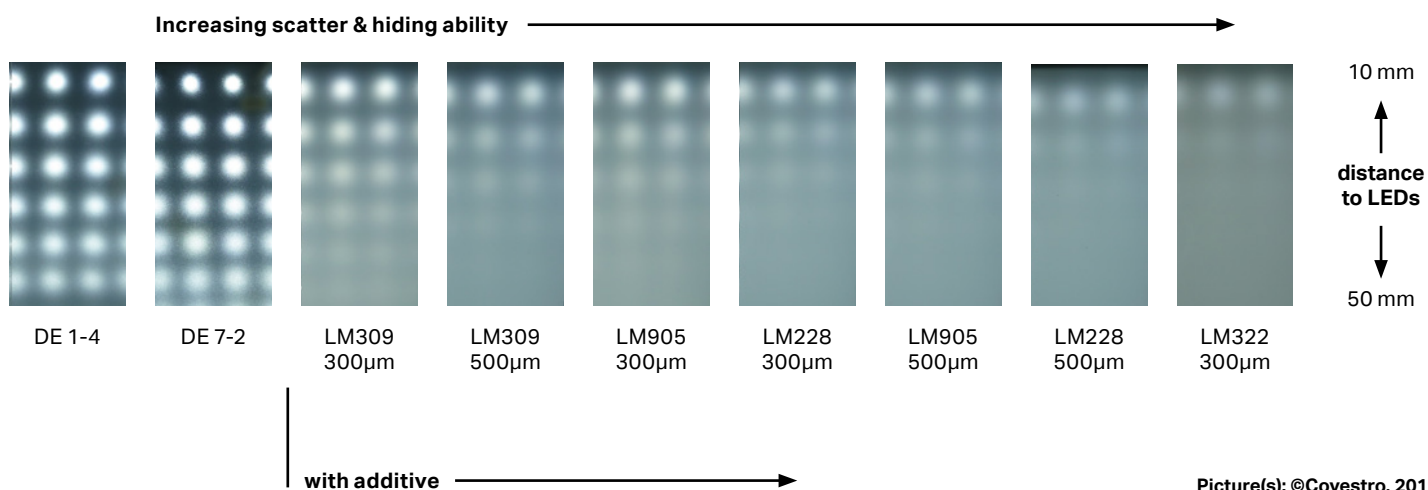
Offering high light transmission for higher light output to help ensure vehicle safety, they are formable to meet signature look and design flexibility requirements.

Light management diffuser films portfolio:

- Diffusion can vary from transparent and slight scattering to translucent and strong diffusion, thereby disguising LED hot spots.
- Covestro offers an array of diffuser films. Makrofol® films offer a broad variety of diffusion and light transmission properties.
- Light scattering effects are influenced by textured surfaces and amount of additive.

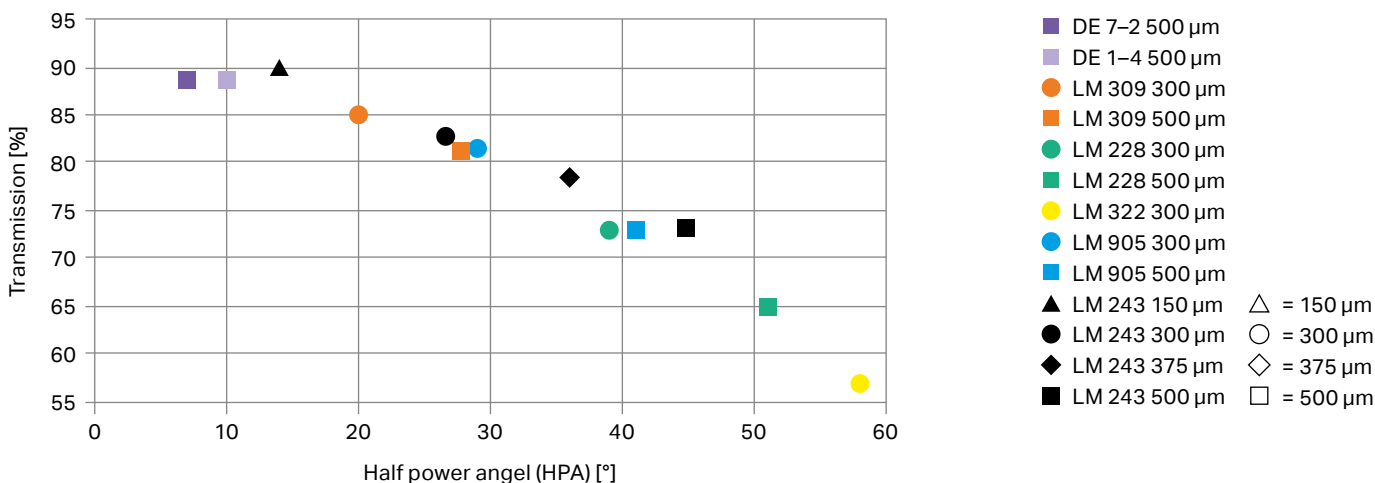
Hiding/homogenization comparison

Makrofol® DE and LM films:

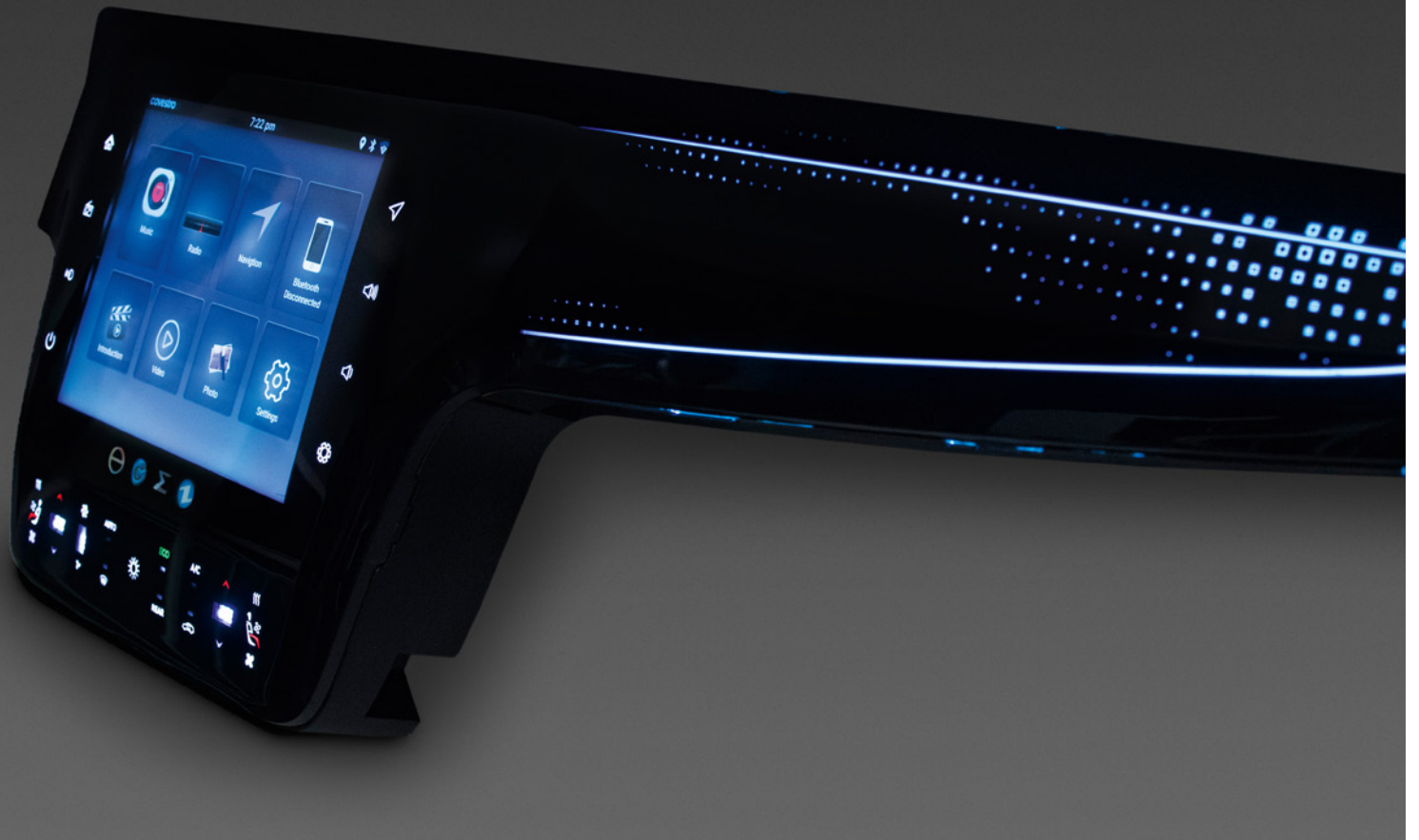


Overview of light management Makrofol® films

Makrofol® LM diffusors



Source: Covestro



Hybrid speedometer instrument cluster integrates analog and digital elements by using high-performance polycarbonate films

[Hybrid-Speedometer](#) Instrument Cluster technology will penetrate a large share of automobiles in the near future. Covestro developed polycarbonate films, called **Makrofol® LM296** and **Makrofol® LM914** to enable the combination of analog and digital elements within one instrument cluster. Even as the digital shift is happening faster than predicted, Makrofol® LM296 and [Makrofol® LM914](#) still hold tremendous value for seamless integration and simplicity of design. When the ignition is started, the instrumentation becomes visible for a very dramatic effect.

Key properties and benefits:

- Enables 3D surface design as well as a black panel effect
- Color printing on the front and/or backside of film
- Can be used to differentiate interiors with dramatic black panel effects
- Customized for different levels of light transmission with tightly controlled tolerances
- Consistent light transmission with a spectrum of colors
- Integrates anti-glare properties with different gloss level options
- Scratch resistant features can be added.



The surface has a glare resistant black appearance while the ignition is turned off.



When the car is started, the instrumentation becomes visible for a very dramatic effect.

Architectural lighting applications

In addition to the automotive sector, Covestro films provide great benefit to interior lighting. Our select films allow homogenous lighting by diffusing and scattering the light uniformly throughout the part. Our portfolio offers films with various degrees of diffusion to fit your lighting needs.

LEDs in particular offer a number of benefits, including lower energy costs, longer service life, excellent performance, and enhanced sustainability. When designing or manufacturing an LED lighting component for commercial, industrial or residential use, including overhead lighting, street lighting, or displays, Covestro has the solution you need.

Makrofol® grade	Thickness (µm)	Light reflectance (%)
LM903	300/500	>96



Makrofol® light management films



Thickness guide

Light management films	1st surface	2nd surface	6 mil 150 µm	10 mil 250 µm	12 mil 300 µm	15 mil 375 µm	20 mil 500 µm	27.6 mil 700 µm	29.5 mil 750 µm
*Makrofol® LM228 2-4 160005 LED and light diffuser	very fine matte	fine matte			○		○		
Makrofol® LM296 1-2 760150 Automotive, Black panel displays	gloss	very fine matte					○		
Makrofol® LM296 1-2 760165 Automotive, Black panel displays	gloss	very fine matte				○			
Makrofol® LM296 1-2 760275 Automotive, Black panel displays	gloss	very fine matte					○		
Makrofol® LM296 1-2 760350 Automotive, Black panel displays	gloss	very fine matte				○			
Makrofol® LM309 2-4 160004 LED and light diffuser	very fine matte	fine matte			○		○		
Makrofol® LM322 2-4 160006 LED and light diffuser	very fine matte	fine matte			○				
Makrofol® LM903 1-4 160008 LED and reflective white	gloss	fine matte			○		○		
Makrofol® LM905 2-4 160009 LED and light diffuser	very fine matte	fine matte			○		○		
Makrofol® LM907 1-1 060012 LED and light guiding	gloss	gloss		○	○	○	○	○	
Makrofol® LM914 1-2 742080 Automotive, Black panel displays	gloss	very fine matte							○
Makrofol® LM243 2-4 160025 LED and light diffuser	very fine matte	fine matte	○		○	○	○		

*Makrofol® LM228 is an Automotive Manufacturers Equipment Compliance Agency (AMECA) Inc. listed diffuser.



Selection guide

Light management films	1st surface	2nd surface	Color	Comments
*Makrofol® LM228 2-4 160005	very fine matte	fine matte	translucent white	Diffuser
Makrofol® LM296 1-2 760150	gloss	very fine matte	grey	Black panel, 50 % Light Transmission
Makrofol® LM296 1-2 760165	gloss	very fine matte	grey	Black panel, 65 % Light Transmission
Makrofol® LM296 1-2 760275	gloss	very fine matte	grey	Black panel, 75 % Light Transmission
Makrofol® LM296 1-2 760350	gloss	very fine matte	grey	Black panel, 50 % Light Transmission
Makrofol® LM309 2-4 160004	very fine matte	fine matte	translucent white	Diffuser
Makrofol® LM322 2-4 160006	very fine matte	fine matte	translucent white	Diffuser
Makrofol® LM903 1-4 160008	gloss	fine matte	reflective white	≥96 % reflective white
Makrofol® LM905 2-4 160009	very fine matte	fine matte	translucent white	Diffuser
Makrofol® LM907 1-1 060012	gloss	gloss	colorless transparent	Light guiding
Makrofol® LM914 1-2 742080	gloss	very fine matte	grey	Black panel, 80 % Light Transmission
Makrofol® LM243 2-4 160025	very fine matte	fine matte	translucent white	Diffuser
**Makrofol® LM297 H-M 040007	grated surface	matte	colorless transparent	Diffuser

*Makrofol® LM228 is an Automotive Manufacturers Equipment Compliance Agency (AMECA) Inc. listed diffuser.

**Makrofol® LM297 H-M 040007 is available per request in 130, 180 and 280 µm.

Emerging technologies

Polycarbonate films bring design and functionality to automotive applications. A notable feature for emerging technologies is their ability to house embedded electronics. With this approach, electronic circuits can be printed onto flat film, and then thermoformed to create a desired shape and overmolded. For example, defroster headlamps – designed and manufactured by

Advanced Decorative Systems and JW Speaker – use screen printed circuits on [Covestro film](#). The resulting smart lens technology offers a solution for LED lights that don't generate enough heat to defrost in colder weather. In-mold electronics can be used for a wide variety of applications from lighting, to instrument panels and more.

Defroster headlamp

Designed and manufactured by Advanced Decorative Systems and JW Speaker.



Scan to learn more about Makrofol® LM films



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