



Illuminating ideas: Enabling lighting excellence with specialty films.

**Makrofol®**



# Makrofol® light management films

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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.

### Characteristics 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 rear lighting applications, Covestro offers lightweight diffuser films made from polycarbonate.

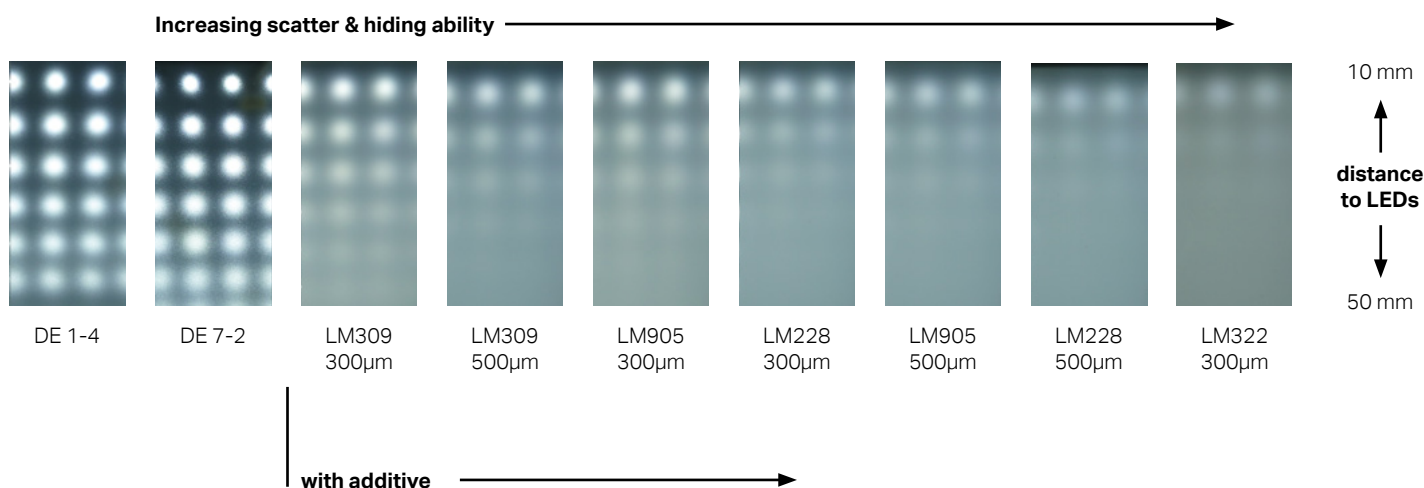
Offering high light transmission for higher light output to help ensure vehicle safety, they are formable to meet signature look and design flexibility requirements.

### 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.

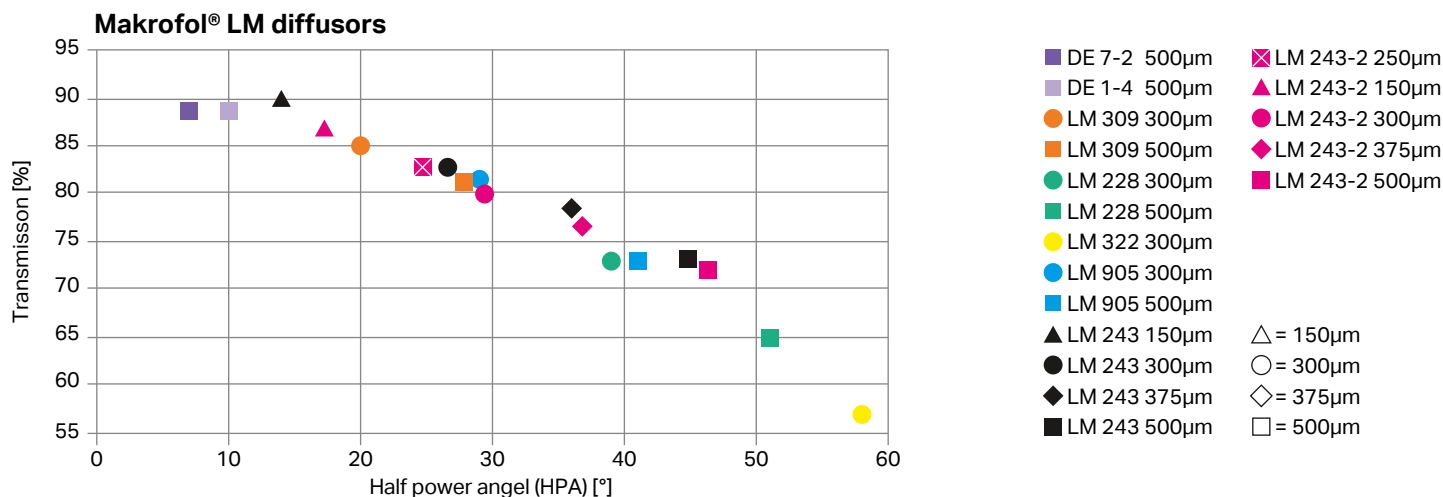
## Hiding/ homogenization comparison:

**Makrofol®** DE and LM films:



Picture(s): ©Covestro, 2019

## Overview of light management Makrofol® films:



Source: Covestro

# Makrofol® light management films



## Hybrid speedometer instrument cluster integrates analog and digital elements by using a high-performance polycarbonate film:

Hybrid-Speedometer Instrument Cluster technology will penetrate a large share of automobiles in the near future. Covestro developed a polycarbonate film, called **Makrofol®** LM296 to enable the combination of analog and digital elements within one instrument cluster. Even as the digital shift is happening faster than predicted, LM296 still holds 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:

- The film 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
- **Makrofol®** LM296 is 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



# Makrofol® light management films



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:

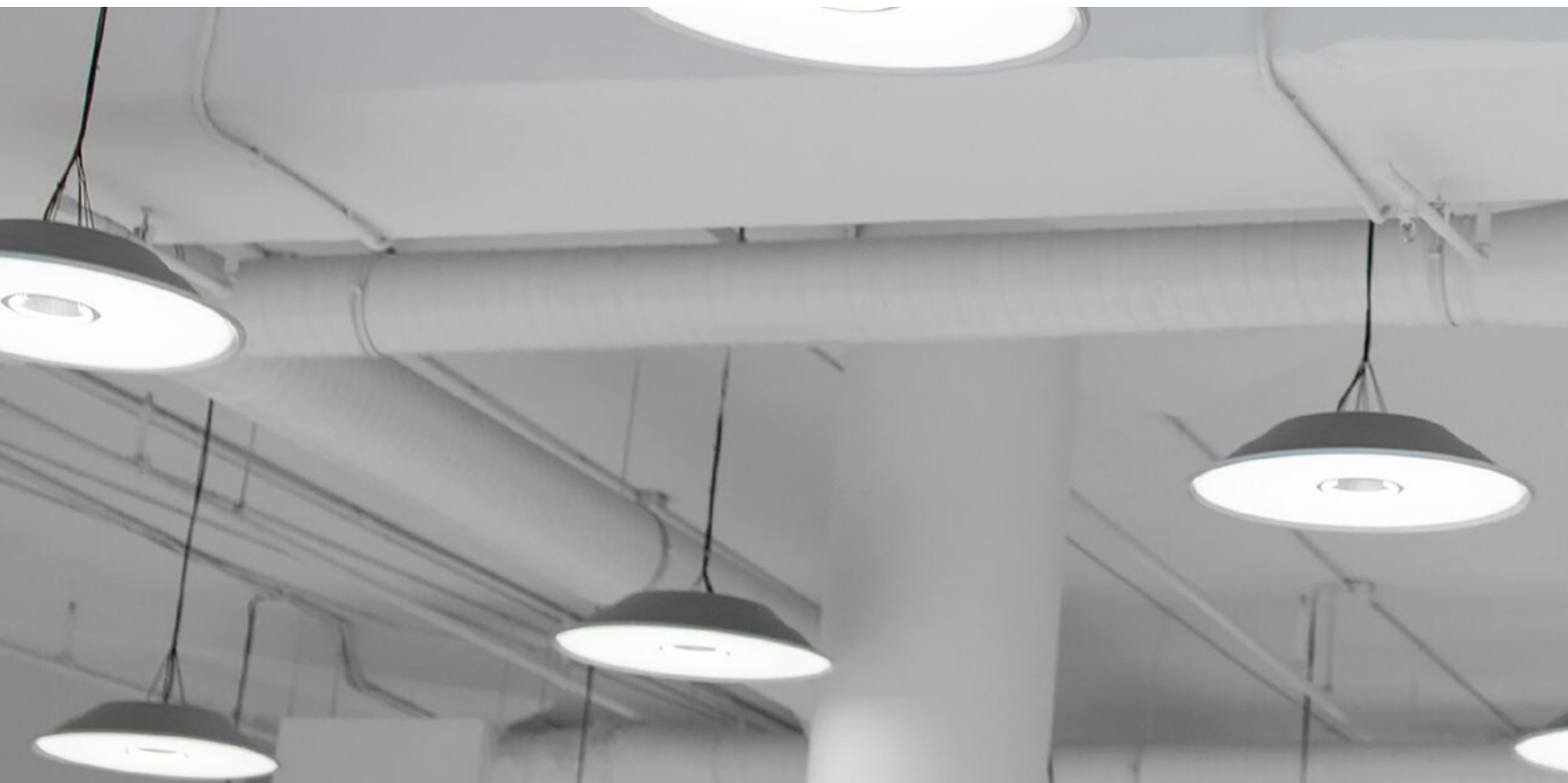
In addition to the automotive sector, Covestro films provide great benefit to interior lighting. Our select films allow homogenous lighting by diffusing and scattering the light uniformly throughout the part. Our portfolio offers films with various degrees of diffusion to fit your lighting needs.

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 (%)
LM 903	300/500	>96



# Makrofol® light management films



## Thickness guide:

Light management films	1 st surface	2nd surface	6 mil 150 µm	10 mil 250 µm	12 mil 300 µm	15 mil 375 µm	20 mil 500 µm	30 mil 750 µm
<b>Makrofol® LM228 2-4 160005</b> LED and light diffuser	very fine matte	fine matte			○		○	
<b>Makrofol® LM296 1-2 760125</b> Automotive, TFT displays	gloss	very fine matte					○	
<b>Makrofol® LM296 1-2 760135</b> Automotive, TFT displays	gloss	very fine matte					○	
<b>Makrofol® LM296 1-2 760150</b> Automotive, TFT displays	gloss	very fine matte					○	
<b>Makrofol® LM296 1-2 760165</b> Automotive, TFT displays	gloss	very fine matte				○		
<b>Makrofol® LM296 1-2 760250</b> Automotive, TFT displays	gloss	very fine matte						○
<b>Makrofol® LM296 1-2 760275</b> Automotive, TFT displays	gloss	very fine matte					○	
<b>Makrofol® LM296 1-2 760350</b> Automotive, TFT displays	gloss	very fine matte				○		
<b>Makrofol® LM296 1-2 760450</b> Automotive, TFT displays	gloss	very fine matte					○	
<b>Makrofol® LM309 2-4 160004</b> LED and light diffuser	very fine matte	fine matte			○		○	
<b>Makrofol® LM322 2-4 160006</b> LED and light diffuser	very fine matte	fine matte			○			
<b>Makrofol® LM903 1-4 160008</b> LED and light diffuser	gloss	fine matte			○		○	
<b>Makrofol® LM905 2-4 160009</b> LED and light diffuser	very fine matte	fine matte			○			
<b>Makrofol® LM243 2-4 160025</b> LED and light diffuser	very fine matte	fine matte	○		○	○	○	



## Selection guide:

Light management films	1 st surface	2nd surface	Color	Comments
<b>Makrofol® LM228 2-4 160005</b>	very fine matte	fine matte	translucent white	Diffuser
<b>Makrofol® LM296 1-2 760125</b>	gloss	very fine matte	grey	Black panel, 25% Light Transmission
<b>Makrofol® LM296 1-2 760135</b>	gloss	very fine matte	grey	Black panel, 35% Light Transmission
<b>Makrofol® LM296 1-2 760150</b>	gloss	very fine matte	grey	Black panel, 50% Light Transmission
<b>Makrofol® LM296 1-2 760165</b>	gloss	very fine matte	grey	Black panel, 65% Light Transmission
<b>Makrofol® LM296 1-2 760250</b>	gloss	very fine matte	grey	Black panel, 50% Light Transmission
<b>Makrofol® LM296 1-2 760275</b>	gloss	very fine matte	grey	Black panel, 75% Light Transmission
<b>Makrofol® LM296 1-2 760350</b>	gloss	very fine matte	grey	Black panel, 50% Light Transmission
<b>Makrofol® LM296 1-2 760450</b>	gloss	very fine matte	grey	Black panel, 50% Light Transmission
<b>Makrofol® LM309 2-4 160004</b>	very fine matte	fine matte	translucent white	Diffuser
<b>Makrofol® LM322 2-4 160006</b>	very fine matte	fine matte	translucent white	Diffuser
<b>Makrofol® LM903 1-4 160008</b>	gloss	fine matte	reflective white	≥95% reflective white
<b>Makrofol® LM905 2-4 160009</b>	very fine matte	fine matte	translucent white	Diffuser
<b>Makrofol® LM243 2-4 160025</b>	very fine matte	fine matte	translucent white	Diffuser
<b>Makrofol® LM297 H-M 040007</b>	grated surface	matte	colorless transparent	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.



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