



Makrofol®

Illuminating Ideas:
Specialty Films
Enabling Lighting Excellence



Makrofol® Light Management Films

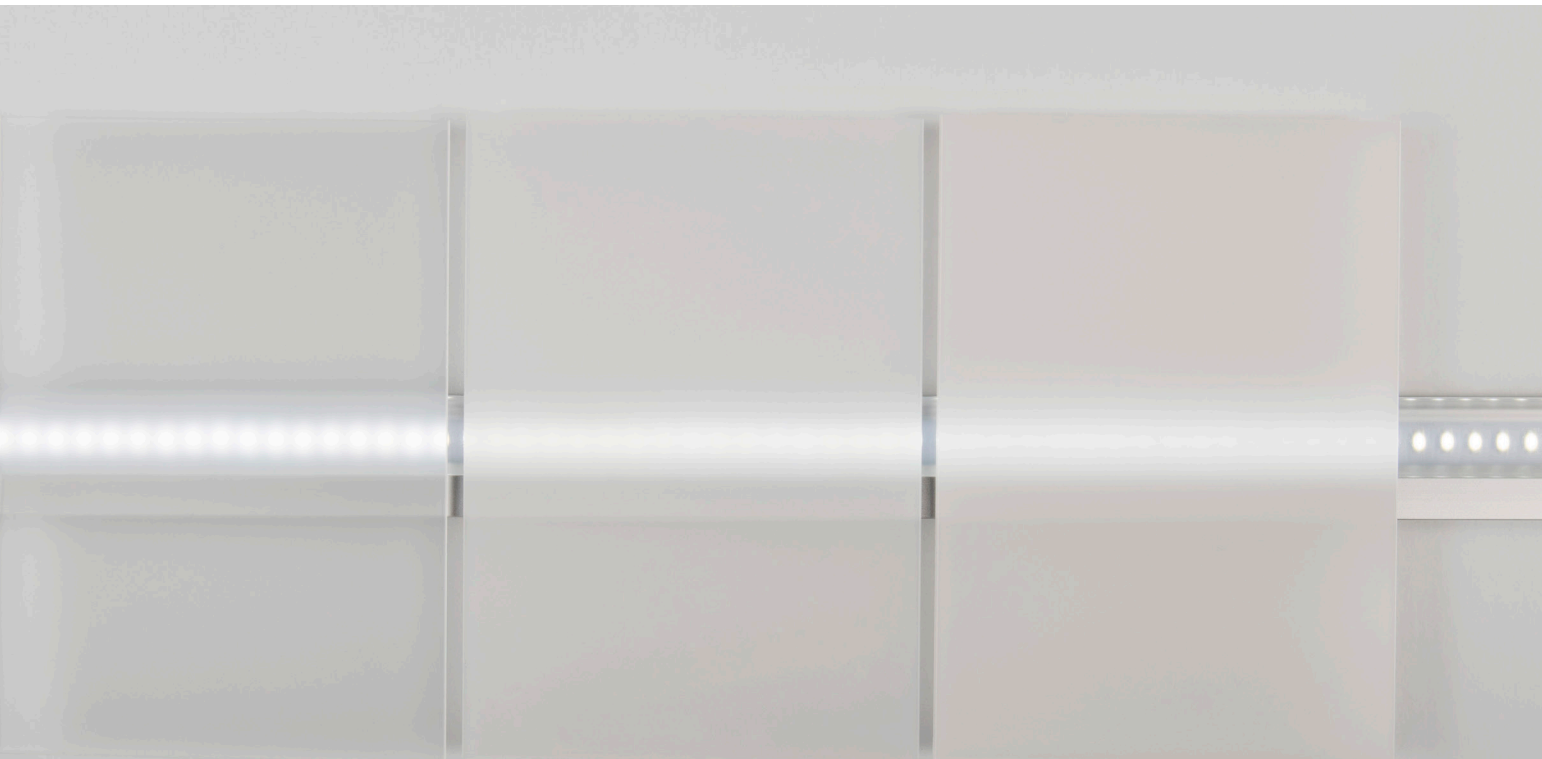
LEDs are transforming the world of lighting and offer new, exciting design possibilities. But LED sources also pose challenges when it comes to glare, hotspots, and light uniformity which often requires the use of diffusion lenses. As a recognized global leader in medical, automotive, consumer electronics, and construction applications, Covestro also offers the latest in lighting solutions with Makrofol® translucent polycarbonate film. Designed for LED lighting, Makrofol® films provide a range of diffusion levels with optimized light transmission – delivering unsurpassed quality and performance. Makrofol® film features higher impact strength than glass or acrylic, and superior temperature resistance over acrylic. The superior 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. These films form easier, deeper, and more consistently than other materials. Makrofol® 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.



Makrofol® Light Management Films

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.

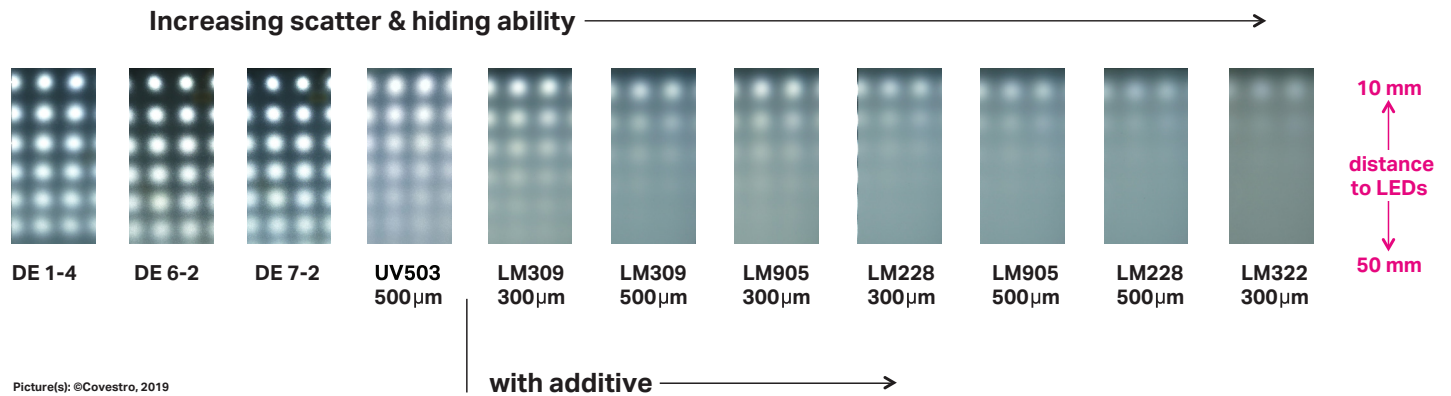
Offering high light transmission for higher light output to help ensure vehicle safety, they are formable to meet signature look and design flexibility requirements.

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.

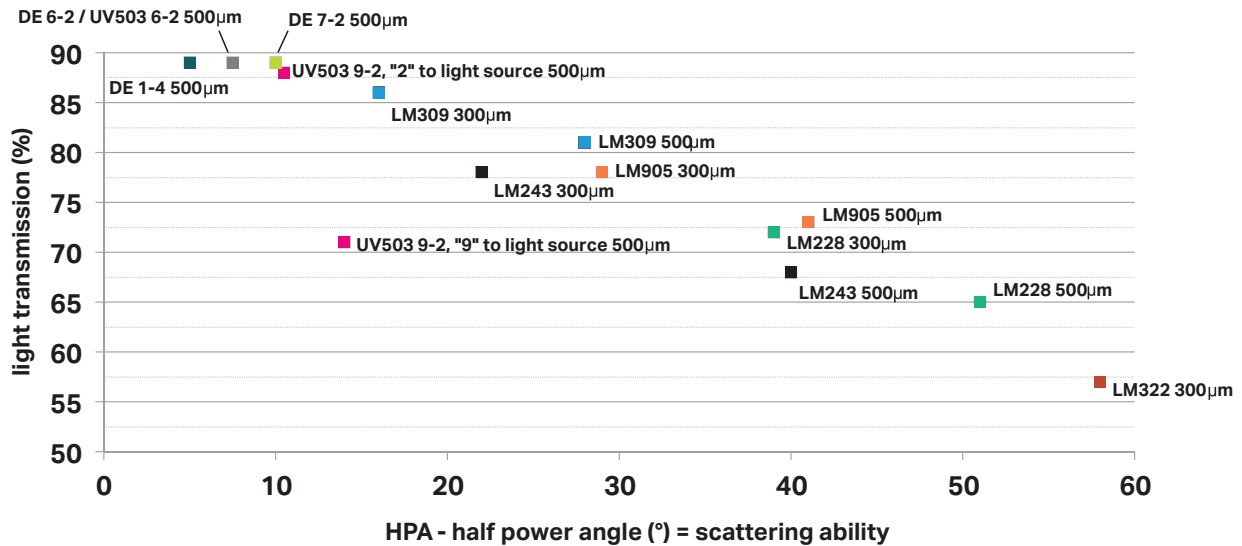
Hiding/Homogenization Comparison

Makrofol® DE and LM Films



Overview of Light Management Films

Makrofol® Films



Makrofol® Light Management Films

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

Experts have suggested that the hybrid speedometer instrument cluster technology would penetrate 80-90% of automobiles. Covestro developed a unique 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



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.



Makrofol® Light Management Films

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® films for diffusive reflectors

Makrofol® grade	Thickness (µm)	Light reflectance (%)
LM 903	300/500	> 96



Makrofol® Light Management Films

Product Portfolio

Grade	1st Surface	2nd Surface	Color	10 mil 250 µm	12 mil 300 µm	20 mil 500 µm	30 mil 750 µm
Makrofol® LM228 2-4 160005	very fine matte	fine matte	natural		○	○	
LED and light diffuser							
Makrofol® LM296 1-2 760125	gloss	very fine matte	neutral density			○	
Automotive, TFT displays							
Makrofol® LM296 1-2 760225	gloss	very fine matte	neutral density				○
Automotive, TFT displays							
Makrofol® LM309 2-4 160004	very fine matte	fine matte	natural		○	○	
LED and light diffuser							
Makrofol® LM322 2-4 160006	very fine matte	fine matte	natural		○		
LED and light diffuser							
Makrofol® LM903 1-4 160008	gloss	fine matte	reflective white		○	○	
LED boards, reflectors							
Makrofol® LM905 2-4 160009	very fine matte	fine matte	natural		○	○	
LED and light diffuser							
Makrofol® UV503 9-2 060004	rough velvet	very fine matte	clear	○		○	○
Diffuser for automotive lighting requiring AMECA materials							



Makrofol® Light Management Films

Selection Guide

Grade	1st Surface	2nd Surface	Comments
Makrofol® LM228 2-4 160005	very fine matte	fine matte	Diffuser
Makrofol® LM296 1-2 760125	gloss	very fine matte	Black panel, available in 25%, 35% & 50% LT
Makrofol® LM309 2-4 160004	very fine matte	fine matte	Diffuser
Makrofol® LM322 2-4 160006	very fine matte	fine matte	Diffuser
Makrofol® LM903 1-4 160008	gloss	fine matte	≥95% reflective white
Makrofol® LM905 2-4 160009	very fine matte	fine matte	Diffuser
Makrofol® UV503 9-2 060004	rough velvet	very fine matte	Also available in gloss / gloss and fine velvet / very fine matte

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

The manner in which you use our products, technical assistance and information (whether verbal, written or by way of production evaluations), including any suggested formulations and recommendations, are beyond our control. Therefore, it is imperative that you test our products to determine suitability for your processing and intended uses. Your analysis must at least include testing to determine suitability from a technical, health, safety, and environmental and regulatory standpoint. Such testing has not necessarily been done by Covestro, and Covestro has not obtained any approvals or licenses for a particular use or application of the product, unless explicitly stated otherwise. Any samples provided by Covestro are for testing purposes only and not for commercial use.

Unless we otherwise agree in writing, all products are sold strictly pursuant to the terms of our standard conditions of sale which are available upon request. All information, including technical assistance, is given without warranty or guarantee and is subject to change without notice. It is expressly understood and agreed by you that you assume and hereby expressly release and indemnify us and hold us harmless from all liability, in tort, contract or otherwise, incurred in connection with the use of our products, technical assistance, and information. Any statement or recommendation not contained herein is unauthorized and shall not bind us. Nothing herein shall be construed as a recommendation to use any product in conflict with any claim of any patent relative to any material or its use. No license is implied or in fact granted under the claims of any patent.

Makrofol® is a registered trademark of Covestro.

©2021 Covestro LLC. All rights reserved.



Covestro LLC
Specialty Films
8 Fairview Way
South Deerfield, MA 01373
413-665-7016

www.films.covestro.com
CAS_FILMS@covestro.com

COV-287 5/2021