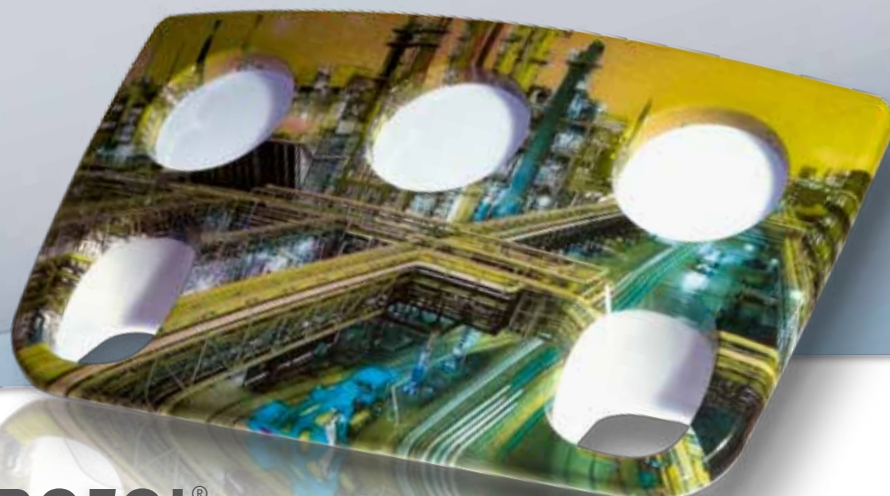




Visions with Functional Films



MAKROFOL[®]



BAYFOL[®]

INNOVATION & EXCELLENCE IN FILMS

We supply more than just films

Global presence, global service

You're in good hands with us! As one of the few global suppliers of polycarbonate films, with production locations in Europe, North America and Asia, we supply films of consistent high quality to all the world's major markets.

Our films can often do a lot more than one might suppose, given the properties of the plastics on which they are based. We provide them with a wide variety of useful extra features and functions by structuring the surface, incorporating additives, applying a coating etc. Typical additional properties include high scratch resistance, excellent UV resistance and special light diffusion properties. For film coating, we have installed a multipurpose coating line at our Leverkusen site.

You also benefit from our globally available technical service, which is a guarantee of our success. A significant percentage of our business is generated by the development of customized solutions. Our service is always available to you wherever you do business. In addition to our new functional films research center in Singapore and our Leverkusen coating line, our Technical Service Centers for films

in Pittsburgh (USA), Map Tha Phut (Thailand) and Leverkusen (Germany) and our new research center for functional films in Singapore form the backbone of this support system. At these centers, we duplicate the entire film processing chain for you, from printing, trimming and punching through to the forming and injection molding. We also help our customers to select the best materials for their applications, engineer products and processes, test materials and components, handle logistics and finally start up production. And we go a step further: Based on customer specifications, we develop entirely new film formulations for promising applications.

Product range

MAKROFOL® PC film	BAYFOL® PC blend & non-PC films
Makrofol® DE PC film	Bayfol® CR/Bayfol® CREC PC/PBT blend film
Makrofol® UV PC film with UV resistance	Bayfol® AS-A PC/PBT blend film, anti-static, black
Makrofol® FR PC film flame retardant V-o	Bayfol® DF-A ABS film, colored
Makrofol® SR PC film with scratch resistance	Bayfol® HX Holographic Photopolymer films
Makrofol® HS Films with scratch-resistant coat	
Makrofol® HF Films with scratch-resistant coat (formable)	
Makrofol® ID PC films for ID cards	
Makrofol® BL PC film with light scattering pigment	
Makrofol® LT PC film with glass fibers	

Our service at a glance

Innovative films in cooperation with customers

Our research and development is geared to innovation, with the aim of tapping new applications and markets. We also seek cooperation with customers. Our development expertise is globally organized, with the focus on growth markets. For example, our new Functional Films Research Center in Singapore is specialized in coated high-tech films and nanotechnology. Working with our customers and partners, the Center opens the door to new technologies in electronics, which are used primarily in the emerging markets of Asia.

Our development centers in Singapore and Germany are equipped to upgrade our films with a wide variety of application-specific functions and properties – for example with all kinds of different colors and optical effects, anti-microbial surfaces, or finishes with improved scratch resistance and tactile properties. We have the know-how and the equipment for producing multi-layer film composites. We know how to control the optical properties of our films so that they are highly effective, for example, in the light extraction of OLED systems.

**Why not take advantage of our know-how?
Just contact us!**



MAKROFOL® & BAYFOL®

Our service...

Technical Service Centers for films – practical support for film processing

When it comes to processing Makrofol® and Bayfol®, we support our customers every step of the way. We have established Technical Service Centers for films in Leverkusen, Map Ta Phut and Pittsburgh, which are equipped to duplicate any and all production steps involved in processing films, from the first prototype to full-scale production. In addition to printing equipment such as screen-printing machines, we have machinery to shape films cold or warm. There are also facilities for the forming of films by high-pressure forming. Our customers can also laminate films on special presses while varying temperature and pressure. This is an important option, for example when testing the production of different card formats, such as ID cards or passports. The Technical Service Centers also have injection molding machines for film insert molding (FIM).



...at a glance.

Assistance with engineering, tooling and testing

Besides processing equipment, our Technical Service Centers for films offer systems and machines for conducting various climate tests on films and finished parts.

Another focus of our service is material-specific engineering, including all of the associated simulation and test methods. We use a variety of CAE tools, for example to analyze a component's dynamic properties, natural frequency or static load. Our experts also conduct rheological tests such as mold flow calculations to determine the optimum gating design for optimum filling during film insert molding.



Made-to-measure material solutions

Made-to-measure material solutions for a variety of industries

We offer a widely diversified, high-quality range of polycarbonate-based technical films that cover a broad spectrum of properties. Virtually every industry benefits from the advantages of our films. Automotive, electrical/electronics, packaging, lamps and lighting, information technology, medical technology, ID cards and documents and printed graphics are just some of them.

As one of the global leaders in the field of plastic films, our material development activities are also geared to technologies of the future. For example, we are working with partners on “artificial muscles” based on electro-active film polymers that could serve the consumer electronics industry as actuators and sensors.

Visions with Functional Films



Makrofol® DE

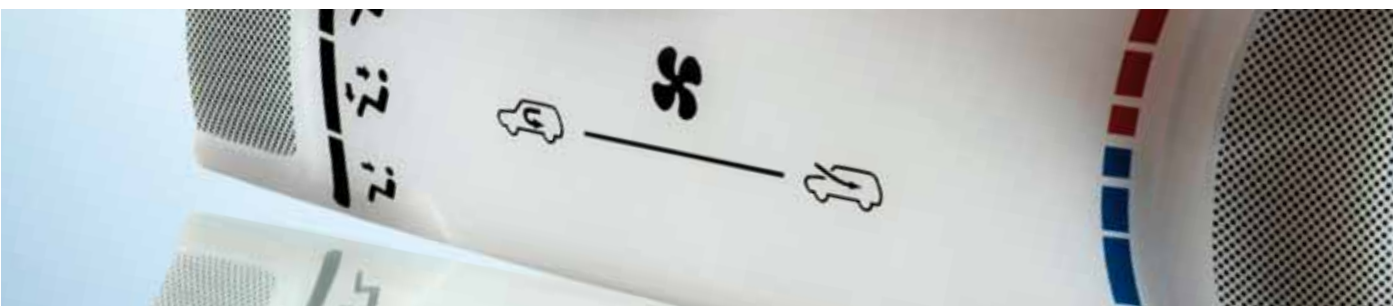
Makrofol® DE is a transparent or colored extruded film made of Bayer MaterialScience's Makrolon® polycarbonate. Makrofol® DE is noted for its outstanding graphic quality. Various surface finishes are available, ranging from high gloss on both sides (1-1), through fine matte (2 or 4) to velvet (6 or 7). The thickness range is between 125 and 750µm, in some cases between 30 and 1,000µm. The high gloss surfaces are masked from scratching by a protective cling or adhesive masking film. Makrofol® DE is used in particular for nameplates, labels, displays and medical applications.

Makrofol® UV

Makrofol® UV is a range of different UV-protected polycarbonate films. They are particularly suitable for parts subjected to high levels of UV light. In addition, they have the well-known benefits of Makrofol® such as good optical, thermal and mechanical properties. Makrofol® UV is available in the surface combinations of (a) glossy on both sides, (b) glossy / fine matte and (c) fine velvet / very fine matte. The available thicknesses, depending on the film type, range from 250µm to 1000µm.

Makrofol® FR

Makrofol® FR 7-2 is a transparent, flame-retardant polycarbonate film with one side velvet and the other with a fine matte finish. With its UL94 V-0 flammability rating, Makrofol® FR 7-2 is suitable for a variety of applications such as trade show displays and nameplates. The film is available in thicknesses from 250 to 750 µm.



Makrofol® SR

Makrofol® SR are polycarbonate films provided with a co-extruded PMMA layer. The films combine the strengths of PMMA, such as high scratch resistance and chemical resistance, with the processing advantages of polycarbonate. They are available with a glossy surface on both sides and are produced in a thickness of 250 µm.

Makrofol® HS

Makrofol® HS films are coated polycarbonate films with very good scratch resistance and chemical resistance. They combine the excellent optical properties of polycarbonate with all the advantages of a surface coating. The films are available with the surface combinations of glossy on both sides or glossy/fine matte, and are available in thicknesses of 180 and 255 µm.

Makrofol® HF

Makrofol® HF is a new product family of polycarbonate films which have a scratchproof coating but can nevertheless be formed. It is coated with a formable Dual Cure system that only finally cures with UV light after forming.

The first representative of this product family is Makrofol® HF 278. The film produces finishes with a deep gloss (piano effect), has very high chemical resistance and good abrasion resistance. It attains a 1H classification on part in the pencil hardness test (ISO 15184, 500 g). The film can be thermoformed with narrow radii and a high depth of draw. It is available in thicknesses of 190, 265 and 390 µm.



Makrofol® ID

Makrofol® ID is a range of special films for cards such as ID cards. In this segment, polycarbonate is favored particularly where high demands exist with regard to service life and exposure to mechanical and thermal loads. Special security features can be integrated, and modifications can be made to guarantee a high-contrast laser printing. White Makrofol® ID grades are mostly used printed as opaque (light-impermeable) inlay films. New optimized grades are under development.

Makrofol® BL

This light-diffusing film has been developed as a special grade for automotive instrument panels (illuminated dials, scales and displays). Makrofol® BL is dazzle-free and scratch-resistant and has a fine matte or velvet surface (2-4 or 6-2). The light-diffusing effect is achieved through the use of a light-scattering pigment, as a result of which this film can also be produced in thicknesses of up to 125 µm. Makrofol® BL is noted above all for giving even illumination over a large surface area from a point light source, making it ideal for creative designs, e.g. in the lighting segment.

Makrofol® LT

Makrofol® LT is also a light-diffusing film, except that here the light-scattering effect comes from the incorporation of fine glass fibers. Because of its fiber content, this film has high dimensional stability and strength. Makrofol® LT films are extruded in thicknesses of between 420 and 750 µm.

Makrofol® LM

Makrofol® LM films are tailor-made for light management applications. The range includes light-scattering, light-guiding and light-reflecting films in various finishes and thicknesses.

Bayfol® AS-A

Bayfol® AS-A is an anti-static, black-colored film made from a PC/PBT blend. Due to its anti-static properties (surface resistance: 10^5 Ohm), this film, which is normally supplied as narrow cut rolls from 10 mm in width, is suitable for the packaging of electronic components. Bayfol® AS-A is available in thicknesses between 200 and 400 μm .

Bayfol® CR/CREC

Bayfol® CR is a blend film of polycarbonate and polyester. This grade has outstanding cold-forming properties e.g. by high-pressure forming and has become established in the film insert molding (FIM) decoration process. Bayfol® CR has excellent chemical resistance and flexibility. The latter makes Bayfol® CR the optimum grade for producing film keypads and membrane switches.

Bayfol® CREC is an extruded film based on a PC/PBT blend. Like Bayfol® CR, it comprises good forming properties and chemical resistance as well as color stability at elevated temperatures. Bayfol® CREC is perfectly suitable for printing applications. Available surface qualities are gloss/fine matte (1-4) and fine velvet/very fine matte (6-2). The thickness range is between 75 and 750 μm . Like Bayfol® CR, Bayfol® CREC is used in particular for membrane switch overlays, nameplates, keypads and control panels.

Bayfol® DF-A

Bayfol® DF-A is a high-grade extruded film made of ABS (acrylonitrile-butadiene-styrene polymer). The films are colored black (other colors also possible in principle) and, because of their excellent surface finish on both sides, are used as carrier film for coating and decorative film, e.g. also in the hot-embossing process. Bayfol® DF-A is extruded as standard in thicknesses between 425 and 500 μm .



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Notes

Codes used in grade names to indicate surface textures:

- 1 = gloss**
- 2 = very fine matte**
- 4 = fine matte**
- 6 = fine velvet**
- 7 = velvet**
- VE = velvet/gloss**

Glossy surfaces can be masked with cling or adhesive film.

Other roll widths, thicknesses, colors and textures on request.

Supply forms

Rolls standard widths:

- **1,000 mm**
- **1,200 mm**
- **1,500 mm***

Cut sheets: on request

Colored film: on request

* only selected grades, Bayfol® DF-A only in 724 mm



Thickness tolerances*

Products	Thickness	Products specification
Makrofol® DE natural	≥ 125 to $175 \mu\text{m}$ > 175 to $375 \mu\text{m}$ $> 375 \mu\text{m}$	$\pm 10\%$ $\pm 7.5\%$ $\pm 5\%$
Makrofol® ID	100 to $750 \mu\text{m}$	± 7.5 to $\pm 2.5\%$
All other grades	30 to $1000 \mu\text{m}$	± 10 to $\pm 3\%$

Roll widths & sheet tolerances

Widths of rolls	≤ 100 mm	Tolerances	± 0.2 mm
	> 100 to 200 mm		± 0.5 mm
	≥ 200 mm		± 1.0 mm
Sheets	Width	Tolerances	± 1.0 mm
	Length		± 1.0 mm
	Angular cut		± 1.0 mm

* The thickness tolerances listed here are guidelines and are dependent on the grade, thickness and color of the film.

Guide

Properties	Test conditions	Units	Test method
Mechanical properties	(23 °C/50 % r.F.)		
Tensile modulus	23 °C	MPa	ISO 527-1, 3
Tensile stress at break, parallel	23 °C	MPa	ISO 527-1, 3
Tensile stress at break, across	23 °C	MPa	ISO 527-1, 3
Tensile strain at break	23 °C	%	ISO 527-1, 3
Thermal properties			
Coefficient of linear thermal expansion, parallel	20–120 °C	10 ⁻⁶ K ⁻¹	DIN 53752
Coefficient of linear thermal expansion, across	20–120 °C	10 ⁻⁶ K ⁻¹	DIN 53752
Shrinkage, parallel	1 h–130 °C	%	IEC 60674
Shrinkage, across	1 h–130 °C	%	IEC 60674
Burning behaviour			
Burning rate	(US-FMVSS)	mm/min	ISO 3795
UL classification			UL 94
Electrical properties	23 °C/50 % r.F.		IEC 60250
Relative permittivity	1 MHz		IEC 60250
Dissipation factor	100 Hz		IEC 60250
Surface resistivity	100 V	Ohm	IEC 60093
Electric strength	1 mm	kV/mm	IEC 60243-1
Electrolytic corrosion	–	Stufe	IEC 60426
Other properties	23 °C		
Water absorption			ISO 62
Density	20 °C	kg/m ³	ISO 1183
Light transmittance	Lichtart; C/2; O/D	%	ISO 13468-2

MAKROFOL®

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PC film	PC film	PC film with filler			PC/PBT blend film	PC/PBT blend film with filler	ABS film
	flame retardant	light scattering			increased chemical resistance	anti-static	
DE, PCVE	FR	BL	BL	LT	CR	AS-A	DF-A
various surface combinations	7-2	2-4	6-2	6-4; 4-4	6-2; 1-4	2-4	1-2
natural, color on request	natural	820816 (natural)	black 820802 200µm 820803 400µm	natural, black 900009	natural	black	900296 black
2200	–	2100	2700/2400	5500	≥ 2100	–	≥ 2400
70	58	≥ 60	≥ 40/≥ 50	60	≥ 55	≥ 50	≥ 30
70	58	≥ 60	≥ 40/≥ 50	50	≥ 55	–	≥ 30
150	–	≥ 100	≥ 20/≥ 60	3	≥ 120	15	15
70	–	40	40/60	70	80	–	–
70	–	40	40/60	70	80	–	–
0.4	–	≤ 0.2	≤ 0.2	0.15	≤ 0.4 1 h–90 °C	0.7 1 h–90 °C	–
0.4	–	≤ 0.2	≤ 0.2	0.15	≤ 0.3 1 h–90 °C	0.7 1 h–90 °C	–
≤ 100	–	≤ 100	≤ 100	≤ 100	–	–	–
VTM-2	V-0; 0.250mm	VTM-2	–	V-2	–	–	–
3.0	–	–	–	–	–	–	–
≤ 100	–	–	–	–	–	–	–
–	–	–	–	–	–	≤ 10 ⁶	–
60	60	–	–	–	–	–	–
A1	–	–	–	–	–	–	–
0.35	0.30	–	–	0.2	–	–	–
1200	1300	1250	1510 / 1350	1410	1230	1300	1040
≥ 80	≥ 80	≥ 80	> 20	≥ 80/≥ 20	> 80	–	–

Service

For further information please contact the appropriate team at the following address.

Technical advice service for:

- **Film application and usage**
- **Questions relating to printing, forming, cutting, film insert molding**
- **Development of new applications**

Europe, Middle East, Africa, Latin America

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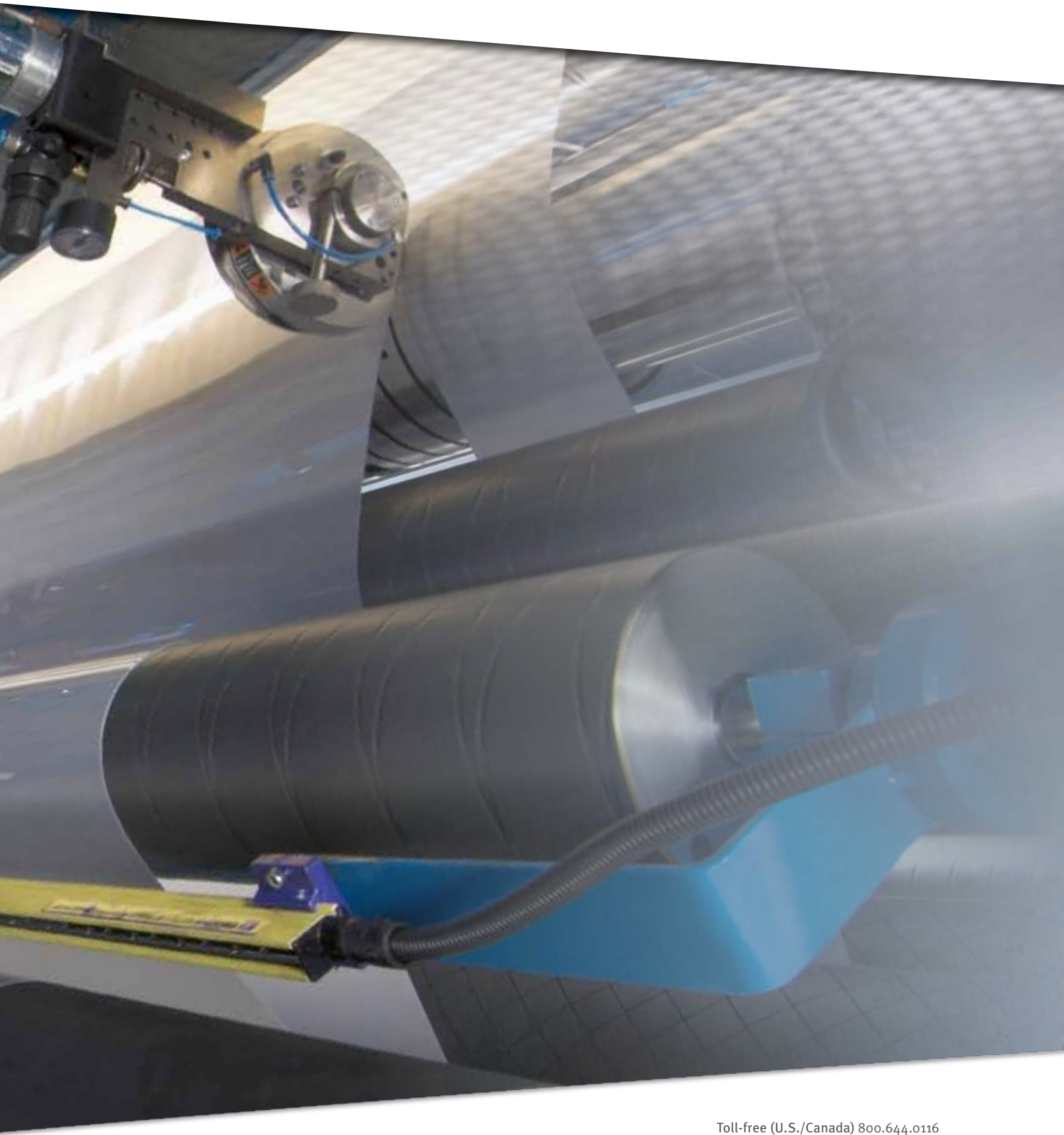
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Visions with Functional Films

The manner in which you use and the purpose to which you put and utilize our products, technical assistance and information (whether verbal, written or by way of product evaluations), including any suggested formulations and recommendations are beyond our control. Therefore, it is imperative that you test our products, technical assistance and information to determine to your own satisfaction whether our products, technical assistance and information are suitable for your intended uses and applications. This application specific analysis must at least include testing to determine suitability from a technical as well as health, safety, and environmental standpoint. Such testing has not necessarily been done by us. 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 and technical assistance is given without warranty or guarantee and is subject to change without notice. It is expressly understood and agreed that you assume and hereby expressly release us 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.



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