

# Makrolon® FR

## Solid flame retardant polycarbonate sheet



### Your benefits:

- excellent fire rating
- resistance to a wide range of temperatures
- extreme impact strength

Solid **Makrolon® FR** sheets are flame retardant polycarbonate sheets. They offer extreme impact strength that exceeds the physical properties of other products of their class. Makrolon® sheets resist temperatures of -100 to +120 °C and exhibit high optical clarity.

**Makrolon® FR** sheets have excellent fire ratings. They are UL94-V0 rated as of 2 mm thickness, comply with EN 45545-2 (European fire standard for rail applications) requirement R4, R22, R23 and R24 and meet FAR 25.853 (a)(1)(i).

**Makrolon® FR clear 099** is a clear transparent sheet with good light transmission.

**Makrolon® FR DX 139** is a diffuser sheet with a cool and fresh color appearance, even when the LEDs are in off mode.

**Makrolon® FR** sheets are the perfect choice for a long service life because of their good material performance.

### Applications:

Typical applications for **Makrolon® FR** sheets include:

- lighting fixtures on railway vehicles
- electro technical components and guards which have to comply with UL94, EN 45545-2 or FAR 25.853 requirements
- any application where improved fire behaviour is needed for fire safe solutions

The sheets offer protection against involuntary breakage and willful destruction. **Makrolon® FR DX** sheets can be thermoformed, cold-curved and machined with ease.

	Test Conditions	Typical Values <sup>(1)</sup>	Unit	Test Method
<b>PHYSICAL</b>				
Density		1200	kg/m <sup>3</sup>	ISO 1183-1
Water absorption saturation	water at 23°C	0.3	%	ISO 62
Water absorption equilibrium	23°C, 50 % RH	0.12	%	ISO 62
Refractive Index	Procedure A	1,587	-	ISO 489
<b>MECHANICAL</b>				
Tensile modulus	1 mm/min	2400	MPa	ISO 527-1,-2
Yield stress	50 mm/min	>60	MPa	ISO 527-1,-2
Yield strain	50 mm/min	6	%	ISO 527-1,-2
Nominal strain at break	50 mm/min	>50	%	ISO 527-1,-2
Flexural modulus	2 mm/min	2400	MPa	ISO 178
Flexural strength	2 mm/min	>90	MPa	ISO 178
Charpy impact strength	23°C, unnotched	non-break	kJ/m <sup>2</sup>	ISO 179-1eU
Charpy impact strength	23°C, 3 mm, notched	70P	kJ/m <sup>2</sup>	ISO 179-1eU
Izod impact strength	23°C, 3,2 mm, notched	80P	kJ/m <sup>2</sup>	ISO 180-A
<b>THERMAL</b>				
Vicat softening temperature	50 N; 50°C/h	146	°C	ISO 306
Thermal conductivity	23°C	0.2	W/(mK)	ISO 8302
Coefficient of thermal expansion	23 to 55°C	0.70	10 <sup>-4</sup> K	ISO 11359-1,-2
Temperature of deflection under load	1.8 Mpa	127	°C	ISO 75-1,-2
	0.45 Mpa	139	°C	ISO 75-1,-2
<b>ELECTRICAL</b>				
Electrical strength	1 mm	34	kV/mm	IEC 60243-1
Volume resistivity		1E14	Ohm.m	IEC 60093
Surface resistivity		1E16	Ohm	IEC 60093
Relative permittivity	100 Hz	3.1	-	IEC 60250
Relative permittivity	1 MHz	3	-	IEC 60250
Dissipation factor	100 Hz	10 10 <sup>-4</sup>	-	IEC 60250
Dissipation factor	1 MHz	90 10 <sup>-4</sup>	-	IEC 60250

<sup>(1)</sup> These values are measured on injection molded samples, and are not intended for specification purposes.

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Ideas, innovative, intelligent, interesting...

Exolon Group i-line represents the next generation of quality products. This seal guarantees innovative and intelligent first-class solutions at all times for a multitude of requirements.

### Available dimensions:

**Makrolon® FR clear 099:** available as 2, 3 and 5 mm sheet thickness in the format 2.050 x 3.050 mm

**Makrolon® FR DX white 139\*:** in 3 mm sheet thickness in the format 2.050 x 3.050 mm

\*Other sizes, colours or sheet thicknesses on request.

Permanent Service Temperature: without load approx. 120 °C.

### Fire Rating\*:

Country	Standard	Rating	Thickness	Colour
Europe	EN 45545-2	R1/ HL1, R3/HL2, R4/ HL3	1.5 - 5 mm	all colours
		R22, R23, R24/ HL3	2 - 5 mm	
Germany	DIN 5510-2	S3/ SR2/ ST2	5.0 mm	clear 099
USA	UL 94	V0	≥ 2,0 mm	all colours
	FAR 25.853	Part 1, (a)(1)(i) – 60 sec Part 1, (a)(1)(ii) – 12 sec	2 – 5 mm	clear 099

\* Fire certificates are limited in time and scope, always check if the mentioned certificate is valid for the purchased polycarbonate sheet type at the date of delivery. Polycarbonate sheets may change their fire behavior due to ageing and weathering. The indicated fire rating was tested on new / unweathered product in accordance with the indicated fire classification standards.

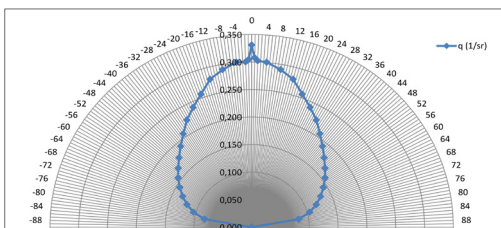
### Light transmission in %, test method according to ISO 13468-2

The stated thicknesses are not all available as standard. The stated values are typical values only.

	Makrolon® FR clear 099				Makrolon® FR DX white 139
Sheet thickness (mm)	3	4	5	6	3
Light transmission (%)	88	86	85	84	53

### Light diffusion Makrolon® FR DX:

Spatial distribution of the luminance coefficient  $\eta$



Results were derived from BTDF measurements:

	Makrolon® FR DX white 139
Sample thickness (mm)	3
Half-power angle [°]	2 x 50°
Light diffusion factor [σ]	63%

$T_c$  and  $R_a$  for the combination of illuminant A and **Makrolon® FR DX** cool 139, as a function of the transmission angle.

Illuminant A	Transmission angle (°)	$R_a$	$T_c$ (K)
$R_a$	0	97.62	2708
99.58	1	97.67	2710
$T_c$ (K)	2	97.66	2714
2856	5	97.62	2726



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