Eye protection for welders:
Makrolon® FP3087

New materials for welder protection applications

Welding work generates dangerous intensity levels of light, with the spectrum ranging from UV to visible and near-infrared (NIR) light. This threat is compounded by the spray of sparks produced by the welding process. Reliable eye protection is therefore critical for both welders and their co-workers.

For welders to see their surroundings with high clarity and little distortion, protective welding goggles and visors must display good optical properties. Good color rendition is of particular importance, for instance so that the wearer can reliably distinguish between signal colors.

The requirements imposed on protective goggles and visors for welders are defined in the German standard EN 169:2002 and ANSI Z87.1-2010, which defines a number of protection levels. Color rendition is covered in EN 1836:1997+A1:2001+A2:2002.

Protective equipment manufacturers injection molding or extruding lenses and visors value ease of fabrication and the ability to easily implement design changes.

Covestro's new material portfolio based on Makrolon® FP3087 combines the proven properties of Makrolon® LQ3187 for visors and tinted safety glasses with the extended demands imposed on protective eyewear for welding work.

Makrolon® FP3087 offers a broad processing window for injection molding and extrusion, high notch impact resistance, easy coatability and reliable UV light transmission cutoff at 400 nm.

The newly developed formulations for welder protection also fulfill special near-infrared-absorption requirements while retaining a neutral gray, transparent color or other transparent color handling This transparent, neutral gray color results in significantly better color rendering in the visible range. This allows equipment operators to better recognize signal colors, reducing the probability of errors.

All compounds in this Makrolon® FP3087 family fulfill the specifications for signal color recognition under EN 1836:1997+A1:2001+A2:2002.

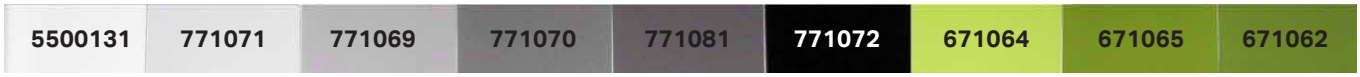
All materials of Makrolon® FP3087 family, are designed as ready-to-use products, which already contain all the necessary additives for injection molding or extrusion.

The product portfolio also enhances molded part dip coating coating setup time and cost. The proprietary formulations do not interfere with coating pot life in coating dip tanks.

The granules in the Makrolon® FP3087 family can be dried and processed either directly or as a mixture of individual components in accordance with the processing instructions for Makrolon® FP3087.

Developed specially for welder protection applications, the materials in the Makrolon® FP3087 family are available in the following grade/color combinations:

Makrolon® grade	Color		thickness [mm]	EN169:2002 Protection level	ANSI Z87.1-2010 Protection level
LQ3187	550131	crystal clear	-	-	-
FP3087	671064	green	2	-	W 3.0
FP3087	671065	green	2	-	W 5.0
1804	671062	green	1.16	-	W 3.0
FP3087	771071	gray	2	1.7	-
FP3087	771069	gray	2	3.0	W 3.0
FP3087	771070	gray	2	5.0	W 5.0
FP3087	771081	gray	2	6.0	W 6.0
1804	771072	gray	1.16	-	W 5.0



Protection levels from 1.2 to 12 to EN 169:2002 and protection levels from ANSI Z87.1-2010 in material thicknesses of 1.0 to 4.0 mm can be obtained by mixing the different colors. The mixing system makes it possible to produce eleven different protection levels in various thicknesses using only five different colors, meaning storage can be optimized as a result.

To obtain all the protection levels defined in EN 169:2002 of 1.2 to 12 using the materials listed, suggested formulations were developed in application thicknesses of 1.0 to 4.0 mm

The table values are no guarantee of the targeted protection level and must be verified by corresponding transmission tests on the finished article by the protective equipment manufacturer.

Suggested formulations for welder protection applications, layer thickness = 1.0 mm

Protection level to EN 169:2002 (1 mm)	Makrolon® grade	Color number	Composition %
1.4	FP3087	771071	100
1.7	FP3087	771069 771071	40 60
2.0	FP3087	771069	100
2.5	FP3087 FP3087	771069 771070	55 45
3.0	FP3087	771070	100
4.0	FP3087	771081	100
5.0	1804	771072	100

Suggested formulations for welder protection applications, layer thickness = 2.0 mm

Protection level to EN 169:2002 (2 mm)	Makrolon® grade	Color number	Composition %
1.2	LQ3187 FP3087	550131 771071	75 25
1.4	LQ3187 FP3087	550131 771071	50 50
1.7	FP3087	771071	100
2.0	FP3087 FP3087	550131 771069	55 45
2.5	FP3087 FP3087	771069 771071	45 55
3.0	FP3087	771069	100
4.0	FP3087 FP3087	771070 771071	55 45
5.0	FP3087	771070	100
6.0	FP3087	771081	100
9.0	1804	771072	100

Suggested formulations for welder protection applications, layer thickness = 3.0 mm

Protection level to EN 169:2002 (3 mm)	Makrolon® grade	Color number	Composition %
1.2	LQ3187 FP3087	550131 771071	85 15
1.4	LQ3187 FP3087	550131 771071	65 35
1.7	LQ3187 FP3087	550131 771069	50 50
2.0	FP3087	771071	100
2.5	LQ3187 FP3087	550131 771069	55 45
3.0	FP3087 FP3087	771069 771071	40 60
4.0	FP3087	771069	100
5.0	FP3087 FP3087	771070 771071	55 45
6.0	FP3087 FP3087	771069 771070	40 60
7.0	FP3087	771070	100
8.0	FP3087	771081	100

Suggested formulations for welder protection applications, layer thickness = 4.0 mm

Protection level to EN 169:2002 (4 mm)	Makrolon® grade	Color number	Composition %
1.2	LQ3187 FP3087	550131 771071	90 10
1.4	LQ3187 FP3087	550131 771071	75 25
1.7	LQ3187 FP3087	550131 771071	50 50
2.0	LQ3187 FP3087	771071 771069	60 40
2.5	FP3087	771071	100
3.0	LQ3187 FP3087	550131 771071	55 45
4.0	FP3087 FP3087	771069 771071	45 55
5.0	FP3087	771069	100
6.0	FP3087 FP3087	771070 771071	55 45
7.0	FP3087 FP3087	771069 771070	50 50
8.0	FP3087 FP3087	771069 771070	30 70
9.0	FP3087	771070	100
10.0	FP3087	771081	100
12.0	1804	771072	100

To obtain all the protection levels defined in ANSI Z87.1-2010 of 2 to 10 using the materials listed, suggested formulations were developed in application thicknesses of 1.0 to 4.0 mm.

Protection level to ANSI Z87.1-2010 (1 mm)	Makrolon® grade	Color number	Composition %
W 3.0	FP3087	771070	100
W 4.0	FP3087	771081	100
W 5.0	1804	771072	100

Protection level to ANSI Z87.1-2010 (2 mm)	Makrolon® grade	Color number	Composition %
W 2.5	FP3087 FP3087	771069 771071	55 45
W 3.0	FP3087	771069	100
W 4.0	FP3087 FP3087	771069 771070	50 50
W 5.0	FP3087	771070	100
W 6.0	FP3087	771081	100
W 9.0	1804	771072	100

Protection level to ANSI Z87.1-2010 (3 mm)	Makrolon® grade	Color number	Composition %
W 2.5	LQ3187 FP3087	550131 771069	55 45
W 3.0	FP3087 FP3087	771069 771071	40 60
W 4.0	FP3087	771069	100
W 5.0	FP3087 FP3087	771070 771071	50 50
W 6.0	FP3087	771069 771070	40 60
W 7.0	FP3087	771070	100
W 8.0	FP3087	771081	100

Protection level to ANSI Z87.1-2010 (4 mm)	Makrolon® grade	Color number	Composition %
W 2.0	LQ3187 FP3087	550131 771071	20 80
W 3.5	FP3087	771071	100
W 3.0	LQ3787 FP3087	550131 771069	55 45
W 4.0	FP3087 FP3087	771069 771071	45 55
W 5.0	FP3087	771069	100
W 6.0	FP3087 FP3087	771070 771071	50 50
W 7.0	FP3087 FP3087	771069 771070	50 50
W 8.0	FP3087 FP3087	771069 771070	30 70
W 9.0	FP3087	771070	100
W 10.0	FP3087	771081	100

Material properties of Makrolon® FP3087

	Properties	Test conditions	Units	Standards	Typical values
Rheological properties					
	Melt volume-flow rate (MVR)	300 °C; 1.2 kg	cm^3/10 min	ISO 1133	7.0
Mechanical properties (23 °C/50 °C r. F.)					
C	Tensile modulus	1 mm/min	MPa	ISO 527-1,-2	2350
C	Yield stress	50 mm/min	MPa	ISO 527-1,-2	66
C	Yield strain	50 mm/min	%	ISO 527-1,-2	6.0
	Stress at break	5 mm/min	MPa	ISO 527-1,-2	75
	Strain at break	5 mm/min	%	i.A. ISO 527-1,-2	125
	Izod notched impact strength	23 °C	kJ/m^2	ISO 7391/i.A ISO 180-A	75
	Izod notched impact strength	-20 °C	kJ/m^2	ISO 7391/i.A ISO 180-A	14
C	Puncture maximum force	23 °C	N	ISO 6603-2	5700
C	Puncture maximum force	-30 °C	N	ISO 6603-2	6500
C	Puncture energy	23 °C	J	ISO 6603-2	62
C	Puncture energy	-30 °C	J	ISO 6603-2	67
Thermal properties					
C	Temperature of deflection under load	1.80 MPa	°C	ISO 75-1,-2	122
C	Vicat softening temperature	50 N; 50 °C/h	°C	ISO 306	142

	Processing conditions for test specimens			
C	Injection molding melt temperature	–	°C	300
C	Injection molding mold temperature	–	°C	80
C	Injection molding injection velocity	–	mm/s	200

C These properties are part of the CAMPUS® plastics database and based on data definitions strictly defined in the international standard ISO 10350.

Typical value
These values are typical values only. Unless explicitly agreed in written form, they do not constitute a binding material specification or warranted values. Values may be affected by the design of the mold/die, the processing conditions and coloring/pigmentation of the product. Unless specified to the contrary, the property values given have been established on standardized test specimens at room temperature.

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