



Product Range – Typical Values



makroblen



Makroblend® is the brand name of polycarbonate (PC) + polybutylene terephthalate (PBT) or polycarbonate (PC) + polyethylene terephthalate (PET) blends produced by Bayer MaterialScience.

Characteristics

Makroblend® is distinguished by

- high toughness (even at low temperatures)
- good chemical resistance
- reduced susceptibility to stress cracking
- good paintability
- low moisture uptake

Applications

Applications for Makroblend® are found in

- automotive engineering
- electrical engineering/electronics
- lighting technology
- sports & leisure

Distinguishing features

Inherent color

- light ivory color, opaque

Color range

- In addition to its natural color and black, a range of opaque standard colors is available. Special colors are possible.

Surface quality

- glossy or matt

Rigidity

- high tensile modulus: 1,800 to 3,900 MPa depending on grade

Impact and break resistance

- high impact strength with high toughness, even at low temperatures

Stress cracking behavior

- resistance to many chemicals and solvents

Heat resistance

- good dependent on grade

Dimensional accuracy and stability

- good, clearly better than semi-crystalline thermoplastics

Chemical resistance

- good, particularly to fuels, lubricants, solvents and cleaning agents

Electrical insulation

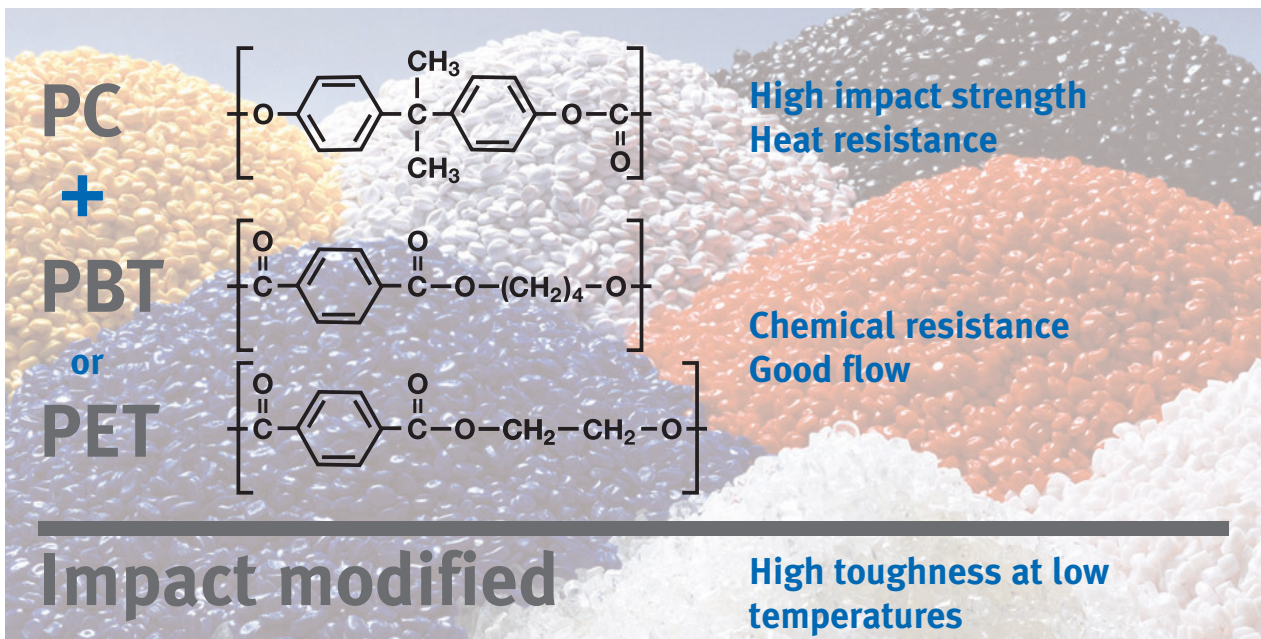
- high electrical resistance

Processability

- free-flowing
- rapid solidification
- short processing cycles

Moisture uptake

- clearly lower than semi-crystalline thermoplastics



The diagram illustrates the chemical structures of the components and the resulting properties of Makroblend:

- PC (Polycarbonate):** $\left[\text{O} - \text{C}_6\text{H}_4 - \text{C}(\text{CH}_3)_2 - \text{C}_6\text{H}_4 - \text{O} - \text{C}(=\text{O}) \right]$
- PBT (Polybutylene terephthalate):** $\left[\text{O} - \text{C}_6\text{H}_4 - \text{C}(=\text{O}) - \text{O} - (\text{CH}_2)_4 - \text{O} - \text{C}(=\text{O}) - \text{C}_6\text{H}_4 - \text{O} \right]$
- PET (Polyethylene terephthalate):** $\left[\text{O} - \text{C}_6\text{H}_4 - \text{C}(=\text{O}) - \text{O} - \text{CH}_2 - \text{CH}_2 - \text{O} - \text{C}(=\text{O}) - \text{C}_6\text{H}_4 - \text{O} \right]$

The resulting Makroblend properties are:

- High impact strength**
- Heat resistance**
- Chemical resistance**
- Good flow**
- Impact modified**
- High toughness at low temperatures**

Overview of product grades

(PC+PET) blends – impact modified

non-reinforced

DP 7645* Injection molding grade
Applications: automotive radiator grilles
mineral filled

mineral filled

DP 2-7655* Injection molding grade, 10% mineral
filled, low linear thermal expansion
Applications: automotive body panels

DP 7665* Injection molding grade, 20% mineral
filled, very low linear thermal expansion
Applications: automotive body panels

(PC+PBT) blends – impact modified

non-reinforced

KU 2-7912/5* Injection molding grade, high flow, high
toughness at low temperatures
Applications: automotive bumpers

KU 2-7940* Injection molding grade, high toughness
at low temperatures
Applications: automotive bumpers

KU 2-7912* Injection molding grade, medium flow,
high toughness at low temperatures,
ideal for painted applications
Applications: automotive body panels

KU 2-7912/4* Injection molding grade, high toughness
at low temperatures, ideal for painted
applications
Applications: automotive body panels

KU 2-7915* Injection molding grade, excellent
toughness at low temperatures, ideal
for painted applications
Applications: automotive internal and
external body panels, bumpers,
E/E power tools

mineral filled

KU 2-7608* Injection molding grade, 10% mineral
filled, low linear thermal expansion
Applications: automotive body panels

KU 2-7609* Injection molding grade, 20% mineral
filled, very low linear thermal expansion
Applications: automotive exterior body
panels

(PBT+PC) blends – impact modified

non-reinforced

S 7916/2 Injection molding grade, excellent
chemical resistance, high toughness at
low temperatures, ideal for painted
applications
Applications: motorcycle body parts

S 7916 Injection molding grade, excellent
chemical resistance, high toughness at
low temperatures, ideal for painted
applications
Applications: motorcycle body parts



Makroblend® Typical values

PC+PET

				non-reinforced	impact modified		
					mineral filled		
Properties	Test Conditions		Standards	DP7645*	DP2-7655*	DP7665*	
Rheological properties							
Göttfert melt viscosity	165 1/s; 260 °C		Bayer test	600			
• Melt volume flow rate (MVR)	250 °C; 2.16 kg	cm³/(10 min)	ISO 1133				
• Melt volume flow rate (MVR)	260 °C; 5 kg		ISO 1133	12	10	4	
• Melt volume flow rate (MVR)	270 °C; 5 kg	cm³/(10 min)	ISO 1133		23	14	
Molding shrinkage parallel/normal, based on general practical experience	600 bar		based on ISO 2577	0.6–0.8	0.6–0.8	0.5–0.7	
Post shrinkage parallel/normal, based on general practical experience	1 h 90 °C	%	based on ISO 2577	0.1–0.2	0.1–0.2	0.1–0.2	
Mechanical properties (23°C/50% r. h.)							
• Tensile modulus	1 mm/min		ISO 527-1, -2	2100	3000	3900	
• Yield stress	50 mm/min	MPa	ISO 527-1, -2	50	50 ¹⁾	50 ¹⁾	
• Yield strain	50 mm/min		ISO 527-1, -2	4.5	4 ¹⁾	4 ¹⁾	
• Nominal strain at break	50 mm/min	%	ISO 527-1, -2	> 50			
• Stress at break	50 mm/min		ISO 527-1, -2	40	50 ¹⁾	50 ¹⁾	
Tensile creep modulus	1 h	MPa	ISO 899-1				
Tensile creep modulus	1000 h		ISO 899-1				
• Charpy impact strength	23 °C	kJ/m²	ISO 179-1eU	N			
• Charpy impact strength	–30 °C		ISO 179-1eU	N			
• Charpy notched impact strength	23 °C	kJ/m²	ISO 179-1eA	55			
• Charpy notched impact strength	–30 °C		ISO 179-1eA				
Izod impact strength	23 °C	kJ/m²	ISO 180-1U	N	N(P)	90	
Izod impact strength	–10 °C		ISO 180-1U		200	70	
Izod impact strength	–30 °C	kJ/m²	ISO 180-1U	N		40	
Izod notched impact strength	23 °C		ISO 180-1A	50	25	9	
Izod notched impact strength	–10 °C	kJ/m²	ISO 180-1A	45			
Izod notched impact strength	–20 °C		ISO 180-1A	23			
Izod notched impact strength	–30 °C	kJ/m²	ISO 180-1A				
Izod notched impact strength	–40 °C		ISO 180-1A				
Flexural modulus	2 mm/min	MPa	ISO 178	2100	3000		
Flexural strength	2 mm/min		ISO 178	75	90		
Flexural strain at flexural strength	2 mm/min	%	ISO 178	5.7	5.5		
Flexural stress at 3.5% strain	2 mm/min		ISO 178	65	80		
Ball indentation hardness		N/mm²	ISO 2039-1	100	105	95	
Thermal properties							
• Melt temperature	10 °C/min	°C	ISO 11357-1, -3				
• Heat deflection temperature under load	1.80 MPa		ISO 75-1, -2	94	111	115	
• Heat deflection temperature under load	0.45 MPa	°C	ISO 75-1, -2		130		
• Vicat softening temperature	50 N; 50 °C/h		ISO 306				
Vicat softening temperature	50 N; 120 °C/h	°C	ISO 306	133	139	138	
• Coefficient of linear thermal expansion, parallel/transverse	23 bis 55 °C		ISO 11359-1, -2	0.7	0.6	0.5	
• US FMVSS 302	>/= 1 mm			passed	passed	passed	
• Burning behavior UL94	1.6 mm	Class Recognition/Bayer test		HB (Bayer)	HB (Bayer)		
• Burning behavior UL94	0.8 mm	Class Recognition/Bayer test		HB (Bayer)	HB (Bayer)		
• Oxygen index	Method A		ISO 4589-2	20	23		



PC+PBT							PBT+PC	
impact modified							impact modified	
non-reinforced			mineral filled				non-reinforced	
KU2-7912/5*	KU2-7940*	KU2-7912*	KU2-7912/4*	KU2-7915*	KU2-7608*	KU2-7609*	S7916/2	S7916
440	570	570	670	700			620	640
7								
30	25	21	16	16	13	11	15	13
0.7–0.9	0.7–0.9	0.7–0.9	0.7–0.9	0.7–0.9	0.6–0.8	0.4–0.6	1.2–1.6	1.2–1.6
0.1–0.2	0.1–0.2	0.1–0.2	0.1–0.2	0.1–0.2	0.1–0.2	0.1–0.2	0.1–0.2	0.1–0.2
2000	2100	2100	2150	2100	2600	3400	1900	1800
50	55	50	50	50	50 ¹⁾	50 ¹⁾	45	40
4	4.5	4	4	4	3.5 ¹⁾	3 ¹⁾	4	4
> 50	> 50	> 50	> 50	> 50			> 50	> 50
40		40	45	40	40 ¹⁾	50 ¹⁾	35	35
							1600	1500
							1200	1200
N	N	N	N	N			N	N
N	N	N	N	N			N	N
60	52	60	60	65			70	69
40	50	45	45	50			25	
N	N	N	N	N	N (P)	160	N	N
N	N	N	N	N			N	N
60	50	60	60	65	30	20		66
45		51	52				54	
38	45	45	45	47				47
	25							
2000	2000	2000	2100	2000	2600	3400	1800	1700
75	78	80	75	80	76	75	63	63
5.5	5.8	5.6	5.5	5.6	5.3	5.0	5.0	5.0
65		70	66	70	70	73	54	54
100		100	100	100	95	90	90	85
224		223	223	222	221	221	223	
82	85	84	85	85	87	93	65	60
100		100	107	106	109	106	115	110
	122						120	119
119		120	125	122	125	120		
0.9	0.9	0.9	0.9	0.9	0.8	0.7	1.1	1.1
passed		passed	passed	passed		passed	passed	passed
HB (Bayer)	HB (Bayer)	HB (Bayer)	HB (Bayer)	HB UL	HB (Bayer)	HB (Bayer)	HB (Bayer)	HB (Bayer)
	HB (Bayer)	HB (Bayer)		HB UL		HB (Bayer)		HB (Bayer)
21		21	21	21	22	21	21	20



Makroblend® Typical values

PC+PET

Properties	Test Conditions	Units	Standards	non-reinforced	impact modified	
				DP 7645*	mineral filled	DP 7665*
				DP 2-7655*		
Glow wire test (GWFI)	2.0 mm	°C	IEC 60695-2-12		700	
Thermal conductivity	23 °C	W/(m·K)	ISO 8302	0.2	0.2	
Electrical properties (23°C/50% r. h.)						
• Relative permittivity	100 Hz		IEC 60250		3.5	3.7
• Relative permittivity	1 MHz		IEC 60250		3.3	3.5
• Dissipation factor	100 Hz	10-4	IEC 60250		38	50
• Dissipation factor	1 MHz	10-4	IEC 60250		190	200
• Volume resistivity		Ohm·m	IEC 60093		> 1E18	> 1E18
• Surface resistivity		Ohm	IEC 60093		> 1E16	> 1E16
• Electric strength	1 mm	kV/mm	IEC 60243-1		36	40
• Comparative tracking index	Solution A	Rating	IEC 60112		250	300
Comparative tracking index	Solution B	Rating	IEC 60112		125	100
Electrolytic corrosion		Rating	IEC 60426		A1	A1
Other properties (23°C)						
• Water absorption	Saturation value in water at 23°C	%	ISO 62		0.9	
• Water absorption	Equilibrium value 23°C; 50% RH	%	ISO 62		0.2	
• Density		kg/m³	ISO 1183	1200	1300	1350
Filter content		%	ISO 3451-1		10	20
Bulk density		g/cm³	ISO 60	0.7	0.7	0.7
Processing conditions for test specimens						
Injection molding melt temperature		°C	ISO 294	270	270	270
Injection molding melt temperature		°C	ISO 294	70	70	70
Injection molding injection velocity		mm/s	ISO 294	200	200	200



PC+PBT							PBT+PC	
impact modified							impact modified	
non-reinforced			mineral filled				non-reinforced	
KU2-7912/5*	KU2-7940*	KU2-7912*	KU2-7912/4*	KU2-7915*	KU2-7608*	KU2-7609*	S7916/2	S7916
750		750	700	750	700	800	650	650
0.2		0.2	0.2		0.2		0.2	0.2
3.2		3.2	3.2	3.2	3.2	3.2	3.1	3.1
3.1		3.1	3.1	3.1	3.1	3.1	3.0	2.9
14		10	15	10	39	26	15	23
125		125	130	120	110	95	150	140
> 1E18		> 1E18	> 1E18	> 1E18	> 1E18	> 1E18	> 1E18	> 1E18
> 1E16		> 1E16	> 1E16	> 1E16	> 1E16	> 1E16	> 1E16	> 1E16
35		31	35	30	33	34	31	
600		600	500	600	250	250	600	600
125		125	100	100	125	125	500	400
A1		A1	A1	A1	A1	A1	A1	A1
0.5	0.5	0.5	0.5	0.5	0.6	0.8	0.5	0.5
0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1200	1200	1200	1200	1200	1250	1300	1200	1200
					10	20		
0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
260	260	260	260	260	260	260	260	260
70	70	70	70	70	70	70	70	70
200	200	200	200	200	200	200	200	200



Processing

Drying

Acceptable residual moisture (injection molding)
maximum 0.02 %, with higher quality requirements lower residual moisture.

	Drying temperature in °C	Drying time in h		
		Dehumidifying dryer (50 % fresh air)	Fresh-air dryer (high-speed dryer)	Dehumidifying desiccant dryer
PC/PBT	100 to 105	4 to 12	2 to 4	2 to 4
PC/PET	110	4 to 12	2 to 4	2 to 4

Data obtained from material stored at ambient temperatures (23°C/50 % r. h.).
When downtimes are longer than 4 hours, drying temperatures should be reduced by around 40°C.

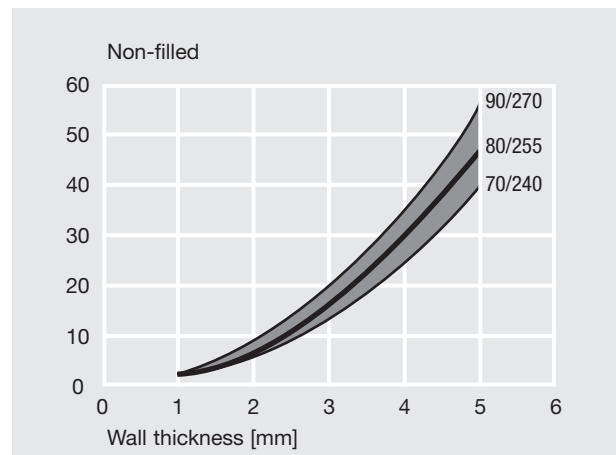
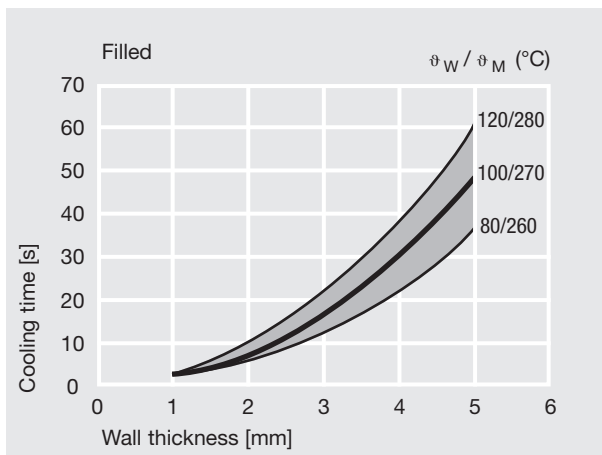
Machinery requirements

Maximum screw peripheral speed 0.3 m/s
Mean cavity pressure (practical experience): 250 to 500 bar –
for easy flowing materials a higher clamping force may be
necessary.

Processing conditions

	Mold temperature in °C	Melt temperature in °C
PC/PBT	60 to 80	250 to 270
PC/PET	60 to 80	260 to 280

Cooling time vs. wall thickness charts



Delivery form

Pellets are available in various types of packaging. The Makroblend® manufacturing units have been certified to DIN ISO 9001 and 14001 by the responsible certification associations.

Recycling

Single-sort post-consumer waste in Makroblend® which does not contain any pollutants can be mechanically recycled. Molded parts containing pollutants can be chemically recycled or incinerated with energy recovery. Parts should be marked in accordance with DIN ISO 11469. The identification for parts in Makroblend® is: >PC+PET-I< or >PC+PBT-I< or >PBT+PC-I<. Mineral-filled grades have the additional suffix MD (e.g. >PC+PBT-I-MD<).

* This is a developmental product. Further information, including amended or supplementary data on hazards associated with its use, may be compiled in the future. For this reason no assurances are given as to type conformity, processability, long-term performance characteristics or other production or application parameters. Therefore, the purchaser/user uses the product entirely at his own risk without having been given any warranty or guarantee and agrees that the supplier shall not be liable for any damages, of whatever nature, arising out of such use. Commercialization and continued supply of this material are not assured. Its supply may be discontinued at any time.

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Unless specified to the contrary, the values given have been established on standardized test specimens at room temperature. The figures should be regarded as guide values only and not as binding minimum values. Please note that, under certain conditions, the properties can be affected to a considerable extent by the design of the mold/die, the processing conditions and the coloring.





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