



TECHNICAL REPORT

SOLID POLYCARBONATE

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SOLID POLYCARBONATE SHEETS

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1 – Technical Information

1.1 – Typical Physical Properties					
	Test Methods			Value	Unit
	DIN	ASTM	ISO		
Physical					
Density	53479	D792	R 1183	1,2	g/cm ³
Water absorption in the atmosphere	53473	D570		0,15	%
Saturation water absorption, 23°C	53495:A		62	0,35	%
Permeability to water	53122			< 2,28	g/m ²
Shrinkage	16901	D955		0,5 - 0,7	%
Optical					
Transmittance		D 1003		87 - 91	%
Haze		D 1003		0,7 - 1,5	%
Reflective Index (n _D)	53491	D 542		1,586	
Thermal					
Heat Distortion Temperature Method B (0.45 Mpa), annealed	53461	D 648	75	145	°C
Method A (1.81 Mpa), annealed	53461	D 648	75	142	°C
Method B (1.81 Mpa), not annealed	53461	D 648	75	125	°C
Specific Heat		D2766		1,25	kJ/kg.K
Thermal Conductivity	52612	C 177		0,2	W/m.K
Thermal Expansion Coefficient	53752	D 696		68	m/m.K x 10 exp(-6)
Vicat softening temperatures (B/50)	53460			148	°C
Flammability rate					
Average burning extension		D 635		< 25	Mm
UL 94, 1,60 mm		UL 94		HB	
UL 94, 3,20 mm		UL 94		HB	
Oxygen Index		D 2863		26	%
Incandescent wire test, 2 mm	VDE 0471 pt2		IEC 695-2-1	850	°C

1 Typical Physical properties				
	Test Method		Value	Unit
	DIN/ ASTM	ISO		
Electrical				
Dielectric resistance, 2 mm (in oil transformer)	VDE 0303 pt2	IEC 243	> 70 10 exp	kV/mm
Volumetric resistivity	VDE 0303 pt3	IEC 93	(16)	Ω.cm
Dissipation factor $\tan \delta \times 10^{\exp(4)}$, 50 Hz	VDE 0303 pt4	IEC 250	5,5	
Dissipation factor $\tan \delta \times 10^{\exp(4)}$, 1 kHz	VDE 0303 pt4	IEC 250	9	
Dissipation factor $\tan \delta \times 10^{\exp(4)}$, 300 kHz	VDE 0303 pt4	IEC 250	80 10 exp	
Superficial Resistivity	VDE 0303 pt3	IEC 93	(15)	Ω
Relative permittivity, 50 Hz	VDE 0303 pt4	IEC 250	3	
Relative permittivity, 1kHz	VDE 0303 pt4	IEC 250	3	
Relative permittivity, 300 kHz	VDE 0303 pt4	IEC 250	3	
Tracking CTI, 2 mm	VDE 0303 pt1	IEC 112	250	V

1.1 Typical Physical Properties					
	Test Methods			Value	Unit
	DIN	ASTM	ISO		
Mechanical					
Tensile resistance, elastic	53455	D 638	R 527	62	Mpa
Tensile resistance, rupture	53455	D 638	R 527	72	Mpa
Elongation, elastic	53455	D 638	R 527	7	%
Elongation, rupture	53455	D 638	R 527	150	%
Elasticity module	53457	D 638	R 527	2300	Mpa
Flexural strength	53452	D 790	178	97	Mpa
Flexural module	53452	D 790	178	2400	Mpa
Compression resistance	53454	D 695	R 604	70	
Shear resistance, elastic		D 732		40	Mpa
Shear resistance, rupture		D 732		60	Mpa
Impact resistance, IZOD, 23°C, notched, 3,20 mm		D 256	R 180	900	J/m
Impact resistance, IZOD, 23°C, un-notched, 3,20 mm		D 256	R 180	NB	J/m
Impact resistance, Charpy, 23°C	53453		179	NB	kJ/m ²
Impact resistance, Charpy, -40°C	53453		179	NB	kJ/m ²
Impact resistance, com entalhe, 23°C	53453		179	50	kJ/m ²
Surface hardness (H30)	53456		2039/2	110	N/m ²
Rockwell hardness, R		D 785		118	
Rockwell hardness, M				72	
Dart Impact, 4,3 m/s, 3,20 mm		D		90	j
Abrasion resistance Taber (500 cycles)		1044		45	Δ%Haze

1.2 – Solar Properties

BEPPC	Light Transm., LT (%)	Solar Refl., R (%)	Absorption Solar (%)	Transmission Direct, DT (%)	Total Solar Transmis. ST (%)	Coefficient of Haze, SC
BRONZE	54	8	42	50	61	0,71
CRISTAL	92	9	9	82	84	0,97
FUMÊ	38	38	22	39	45	0,52

1.3 – Thermal Insulation

One of the advantages of polycarbonate sheets is its big efficiency in preventing loss of heat as compared with other glazing materials, at the same thickness.

To compare the insulation properties of different materials use the U value. It measures the quantity of heat flowing through the material per a defined area per degree of difference of temperature. Therefore, the lower the value of U, the better insulation the material provides to the interior of the building.

Material	Thickness (mm)	U Value (W/m ² K)
BEPPC	2,00	5,56
	3,00	5,41
	4,00	5,27
	5,00	5,13
	6,00	5,00
	8,00	4,76
	10,00	4,55
	12,00	4,35
Tempered Glass	6,00	5,40

2 – Handling and cleaning

To keep the polycarbonate sheet in good condition it clean them periodically using proper cleaning agents, normally domestic cleaning agents.

Please follow the below cleaning instructions:

- Use Luke warm water to rinse the surface that needs to be cleaned;
- Use a solution of Luke warm water and a neutral detergent or neutral soap to wash the sheet surface;
- Use a soft sponge or a soft cloth to gently remove the dirt and soil;

- Use pressurized water for cleaning bigger areas;
- Use ethyl alcohol or kerosene to remove spots of paints and other similar substances;
- Repeat the cleaning process and, at the end, rinse the polycarbonate sheet with clean water. Dry with a soft cloth.

Observe following recommendations:

- Do not rub the sheet using brushes or other sharp objects;
- Do not use squeegee to dry the material;
- Do not use solvents different than recommended or any abrasive material;
- Avoid cleaning materials with high alkalinity;
- Do not clean under strong sun light or high temperature.

3 – Transformation

It is easy to cut Polycarbonate sheets using regular cutting equipment. It is easy to shape the material using regular milling machines with high-speed tools. Notches will harm the mechanical properties of the sheet. Avoid notching.

Recommendation	Panel saw	Tape saw	Miller
Incidence Angle	20° - 30°	20° - 30°	20° - 25°
Detachment Angle	15°	0 - 5°	1 - 5°
Cutting velocity	1800 - 2400m/min	600 - 1000 m/min	100 - 500m/min
Advance speed	19 - 25 m/min	20 - 25 m/min	0,1 - 0,5 mm/rev
Clearance between cutting teeth	2 - 5 mm	1,5 - 2,5 mm	-

3.1 - Drilling

Any metal drilling machine in the market is adequate for drilling

polycarbonate sheet without using any special tool. Observe the following parameters:

Parameters	Valor
Incidence Angle	5 - 8°
Vertices Angle	90 - 130°
Groove Angle	Ca 30°
Detachment Angle	3 - 5°
Drilling Movement Velocity	0,1 - 0,5 mm/rotation
Cutting Velocity	10 - 60 m/min

Observe the following points when drilling polycarbonate sheets:

- Do not use oil;
- Use a new tool which has not be used with other material before;
- The sheet can break as a result of beveling it;
- Drill only 1.5 times the whole diameter far from the sheet edge.
- The whole diameter should be 6 mm bigger than the fixation stick for sheets with length up to 2 meters. For each meter length exceeding 2 meter, add 3 millimeters to the whole diameter.

3.2 – Laser Cutting

Laser machines can cut polycarbonate sheets. The way of cutting will depend on the characteristics and conditions of the cutting machine. Testing is necessary to find the correct operational conditions.

Cutting edge will be rough and colorless. Adjusting the cutting speed can help reducing the intensity of these effects.

Thick sheets can result on oblique cutting. The laser power should be in the range of 250 to 1000 watts. Using one exhausting system is necessary to remove the monomer gases, and other combustion gases formed during the laser cutting.

3.3 – Thermo-molding

Adjusting the parameters for thermo-molding will depend upon the equipment used on the process. This information is only a general guideline. Experimentation is normally going to be necessary to obtain the best results for each specific configuration of the thermos-molding process. Thermo-molding will also reduce the weather resistance of the polycarbonate protect with UV protective additives. It is important to have a minimized and controlled heating, as well as to avoid drawing excessively the material, as a function of the heating or the design of the mold. Again, experimentation is needed to set the proper conditions for each situation to find the most adequate way of thermo-molding the sheets.

Before pre-drying, or before any thermos-molding process, remove the protective masking film, otherwise it will stick strongly to the surface of the polycarbonate sheet.

Simple bending line

1. For one simple bending line pre-drying is normally not necessary;
2. Recommended temperature range is 155°C to 165°C;
3. Width of heated material should be about five times the sheet thickness;
4. Polycarbonate sheets with thicknesses up to 4.0 mm can be bent by heating only one of the sides;
5. Above 4.0 mm it is necessary to heat both sides of the sheet;
6. Avoid too sharp angles. Use as bending ray at least the same dimension as the sheet thickness.

3.4 – Cold Curving

Curving Polycarbonate sheets is possible also at room temperature. The minimum curving ray is to be equal to 150 times the sheet thickness. Using a smaller ray will result on excessive curving and high-tension level, thus reducing impact resistance and duration of the sheet. In addition, chemical resistance of the sheet is diminished, and it will be easily subject to chemical attack.

It is recommendable to limit the curving ray to 175 times the thickness in order to get the best performance of the sheets.

The table below shows the minimum recommended curving ray for each thickness:

Sheet Thickness	Minimum recommended ray
2 mm	300 mm
3 mm	450 mm
4 mm	600 mm
5 mm	750 mm
6 mm	900 mm
8 mm	1200 mm
10 mm	1500 mm
12 mm	1800 mm

A ray of 1500 mm for every thickness, up to 10 mm, is the correct one for polycarbonate sheets with hardened surface (anti-scratch).

3.5 – Gluing

Gluing is done with epoxy, polyurethane, thermoplastic or silicone based adhesives.

Solvents, such as methylene chloride, though providing good adhesion can cause tension cracks. Bérkel does not recommend solvents for gluing.

4 – Guidelines for selecting the correct thickness

The table below indicates a way to assure keeping the deflection of the sheet always below 50 mm.

Procedure:

Establish the load;

Select the sheet width;

Establish the distance of the foothold.

The intersection of the lines indicates the thickness of the polycarbonate sheet to be used to the desired load.

Example:

For a maximum load of 0.90 kN/m² applied over a panel of 1000 mm width foot held at an interval distance of 2000 mm, the thickness of the polycarbonate sheet recommended is 8,0 mm.

Carga	0,60 kN/m ²						0,75 kN/m ²						0,90 kN/m ²						1,05 kN/m ²						1,20 kN/m ²												
	Largura (mm)						Largura (mm)						Largura (mm)						Largura (mm)						Largura (mm)												
Ponto de Apoio (mm)	500	750	1000	1250	1500	1750	2000	500	750	1000	1250	1500	1750	2000	500	750	1000	1250	1500	1750	2000	500	750	1000	1250	1500	1750	2000	500	750	1000	1250	1500	1750	2000		
500	3	3	3	3	4	5	5	3	3	3	3	5	5	5	3	3	4	4	5	5	5	3	3	4	4	5	6	6	3	3	5	5	6	6	8		
750	3	3	3	3	5	5	6	3	3	3	3	5	6	6	3	3	4	4	6	6	8	3	3	4	4	6	8	8	3	5	5	6	8	8	8		
1000	3	3	3	4	5	5	6	3	3	3	3	5	6	8	4	4	4	5	6	8	8	4	4	4	4	6	8	8	5	5	5	6	8	8	10		
1250	3	3	4	4	5	5	6	3	3	3	4	5	6	8	4	4	5	5	6	8	8	4	4	4	5	6	8	8	5	6	6	6	8	8	10		
1500	4	5	5	5	5	6	8	5	5	5	5	6	8	10	5	6	6	6	8	8	10	5	6	6	6	8	10	10	6	8	8	8	8	10	12		
1750	5	5	5	5	6	8	10	5	6	6	6	8	8	10	5	6	8	8	8	10	12	6	8	8	8	10	12	6	8	8	8	10	12				
2000	5	6	6	6	8	10	12	5	6	8	8	10	10	12	5	8	8	8	10	12	6	8	8	8	10	12	6	8	8	8	10	6	8	10	10	12	
2250	5	6	8	8	8	10	12	5	8	8	8	10	12	6	8	8	10	12	8	8	10	10	12	8	8	10	10	12	10	10	10	10					
2500	5	6	8	8	10	12	5	10	10	10	12	6	8	10	10	12	8	8	10	10	8	8	10	10	10	10	10	12									
2750	5	8	8	8	10	5	10	10	10	12	6	10	10	10	8	8	10	12	10	10	10	12	10	10	10	12											
3000	5	8	8	10	12	5	10	10	10	12	6	10	10	12	8	8	10	12	10	10	12	12	10	10	12	12											
3250	5	8	8	10	12	5	10	10	10	6	10	10	12	8	8	12	12	10	10	12																	
3500	5	8	10	10	12	5	10	10	12	6	10	10	12	8	8	12	12	10	10	12																	
3750	5	8	10	10	5	10	10	12	6	10	10	12	8	10	12	10	10	12																			
4000	5	8	10	10	5	10	10	12	6	10	10	12	8	10	12	10	10	12																			
Continuo	5	8	10	12	6	8	12	6	10	12	8	10	12	8	10	12	8	10	12																		

Big care was taken in the compilation of the information herein contained. The recommendations about the use of the products are made without guarantee as the using conditions are not controlled by Bérkel. It is responsibility of the customer provide assurance that the product will be appropriate for each situation and that the conditions of its application be adequate.

Every information of this publication are reliable and issued on good faith. They were though not intended to be a guarantee and therefore we take no legal responsibilities. The users of polycarbonate sheets should run enough experiments as to establish that the material is appropriate of their real particular cases.
