POLYCASA PETG

CONTENTS

POLYCASA PETG

1. PRODUCT IDENTIFICATION

POLYCASA PETG is the brand name for extruded Polyethyleneterephthalate Glycol copolyester sheet from POLYCASA manufactured in accordance with DIN EN ISO 11963. The POLYCASA PETG programme offers solutions to both indoor and outdoor applications. For outdoor use we recommend POLYCASA PETG UV, a material with 10 years warranty.
As a result of the extrusion process, POLYCASA can offer, in addition to the clear, a variety of colours and patterns on request. See the POLYCASA Product selector for range availability.

2. CHARACTERISTICS

POLYCASA PETG sheets have excellent optical properties and a brilliant surface.
The POLYCASA PETG range contains sheets that are easy to fabricate and show exceptional performance at both low and high temperatures (range from -30°C to + 70°C).
Important benefits of POLYCASA PETG sheets are their excellent mechanical, thermal and electrical properties.
They are virtually unbreakable in normal use.
POLYCASA PETG sheets also combine the following excellent properties:

- Easy to vacuum form at low temperatures, need no pre drying
- Exceptional low temperature performance (-30 °C - + 70°C)
- Low water absorption
- Easy to recycle
- Very high impact properties
- Good fire resistance, approved by several fire certificates.

POLYCASA PETG UV sheets are manufactured by coextrusion, which means that the two UV-protection layers are integral with the base sheet. Even after long years of weathering exposure, POLYCASA PETG UV sheets will maintain their clarity.

3. APPLICATIONS

POLYCASA PETG

- Containers, boxes,
- Machine safety guards, vending machine,
- Signs
- Food container
- Refrigerators and cold storeroom equipment
- Road signs
- Office equipment
- Lenticular lenses for printing application special effects moving pictures, 3D, morphing etc.

POLYCASA PETG UV

- Lighting systems
- Balcony screen
- Advertising systems
- Bicycle safety helmets
- Bus shelters
- Packaging for medical devices
- Advertising panels
- Displays & signs for internal and external use

4. FABRICATION AND FINISHING TECHNIQUES

POLYCASA PETG and POLYCASA PETG UV sheets are easy to handle.
Milling, drilling, tapping, sawing, shearing and punching, die cutting, routing, forming, cold and hot bending and welding do not offer any problems to the POLYCASA PETG and the POLYCASA PETG UV range.
More detailed information on these items can be found in the "USER GUIDE", further in this brochure.

5. STATEMENTS

5.1 Food contact

PETG sheets could be used in contact with food. The sheets are a perfect solution for shop fittings and displays presenting food.

PETG sheets attain the requirements of EU directive 1935/2002/EC as well as the European ordinance 10/2011.

Certificate of conformance could be provided on demand from our customer service.

5.2 Fire performance

Fire performance of our PETG and PETG UV sheets clear and coloured are approved in the General Technical Approval Z-56.271-3260 of DIBT (German institute of constructional engineering, Berlin). The approval certifies that our PETG sheets attain fire classification B1 in accordance with DIN 4102-1.
The Technical Approval and other fire performance results are available on request.

5.3 Sound protection

POLYCASA PETG sheets are not tested according to the relevant test standards for sound barrier walls.

5.4 Other certificates

Safety glazing for machines and sports stadium
Certificates are available on request

5.5 Quality Management

POLYCASA PETG and PETG UV are manufactured in accordance with an internal quality managementsystem following the product standard DIN EN ISO 11963.

5.6 Product safety statement

Product Handling Information Sheet is available on request.

5.7 Statement on guarantee for POLYCASA PETG UV

POLYCASA PETG UV is especially suitable for outdoor use.

1. POLYCASA warrants that clear and coloured POLYCASA PETG UV is protected on both surfaces from the adverse effects of UV radiation and, when exposed to moderate North European climates, will not show a significant change in yellowness index and mechanical properties, as described below, for a period of 10 years from the date of sales by POLYCASA.

2. This warranty applies exclusively to clear and coloured POLYCASA PETG UV used correctly as flat sheets which are installed, handled and maintained according to POLYCASA recommendations and instructions. The purchaser is presumed to be informed of said recommendations and instructions. If this is not the case he can obtain said documents through the sales representative or authorised distributor.

3. No warranty will be available for sheets that have been scratched, abraded, cracked or exposed to corrosive materials or environments, nor for sheet that has notches (resulting for instance from sawing) or if the protective layer of the sheet has been damaged in any manner whatsoever. Furthermore, this warranty does not apply to product that has been exposed to extremes of temperature for prolonged periods of time.

4. In the event of a claim against this warranty, the sheet and the original sales receipt must be returned to POLYCASA via the sales representative or original authorised distributor.

5. The extent of yellowing will be determined on samples of the sheet in question according to the Yellowness Index Test DIN 6167 / ASTM D1925 (1977). Multiple samples will be taken from the sheet and cut into sizes suitable for testing; the samples will be cleaned prior to testing. A POLYCASA PETG UV showing a change in yellowness index of an average less than 10 Delta units compared to its original value, as defined by POLYCASA on the date of manufacturing, will not be subject to any claim.

6. The mechanical properties are defined by the flexural modulus (ISO 178), the tensile strength (ISO 527) and Charpy Impact (unnotched ISO 179 at 23°C). Multiple samples will be taken and a sheet showing a change of less than 10% in the flexural modulus and the tensile strength compared to its original value, as defined by POLYCASA on the date of manufacturing, will not be subject to any claim. For the impact test multiple samples will be taken and only those sheets not achieving an average of NB (no break), as defined in ISO 179, will be subject to any claim. The section on Charpy impact applies only to flat sheets, not to patterned sheets.

7. In In the event of a claim against this warranty proving justified, POLYCASA will provide a replacement for the material at issue without any other liability for any other additional indemnification whatsoever:
   - Up to 5 years' time from the purchase date, POLYCASA will replace 100% material.
   - Within 6 years' time from the purchase date, POLYCASA will refund 75% material costs.
   - Within 7 years' time from the purchase date, POLYCASA will refund 60% material costs.
   - Within 8 years' time from the purchase date, POLYCASA will refund 45% material costs.
   - Within 9 years' time from the purchase date, POLYCASA will refund 30% material costs.
   - Within 10 years' time from the purchase date, POLYCASA will refund 15% material costs.

   If replacement material cannot be provided within a reasonable period of time, POLYCASA may choose to refund the original cost of the material without any other liability for any additional indemnification whatsoever. This warranty does not, for instance, cover re-installation expenses or any other incidental costs, which may result from a breakage.

8. There are no express or implied, written or oral warranties and or representations by POLYCASA including warranties and representations of merchantability or fitness of purpose, except as set forth herein.

6. TECHNICAL INFORMATION

6.1 Technical Data Sheet

General			
Property	**Method**	**Units**	**POLYCASA PETG POLYCASA PETG UV**
Density	ASTM D1505	g/cm³	1.27
Rockwell-Hardness	ASTM D-785	R-Scale	105
OPTICAL			
Property	**Methode**	**Einheit**	**POLYCASA PETG POLYCASA PETG UV**
Light Transmission	DIN 5036	%	88
Refractive Index	DIN 53491		1.57
Dulling	ASTM D1003	%	<1
MECHANICAL			
Property	**Methode**	**Einheit**	**POLYCASA PETG POLYCASA PETG UV**
Flexural Modulus	DIN EN ISO 178	MPa	2290
Flexural Strength	DIN EN ISO 178	MPa	89
Tensile Modulus	DIN EN ISO 527	MPa	2200
Tensile Strength	DIN EN ISO 527	MPa	59
Elongation	DIN EN ISO 527	%	23
THERMAL			
Property	**Methode**	**Einheit**	**POLYCASA PETG POLYCASA PETG UV**
Vicat-Temperatur (B)	DIN 53460	°C	82
Heat Deflection Temp. (A/B)	DIN 53461	°C	72/68
Specific Heat Capacity	DIN 2766	J/gK	1.1
Coefficient of linear thermal expansion	DIN 53752	$K^{-1} \times 10^{-5}$	6.8
Thermal conductivity	DIN 52612	W/mK	0.20
Degradation temperature		°C	>280
Max. service temperature continuous use		°C	65
Temperature range		°C	-30 - +70
Max service temperature short term use		°C	70
Sheet forming temp. range		°C	105 - 150
IMPACT STRENGTH			
Property	**Method**	**Unit**	**POLYCASA PETG POLYCASA PETG UV**
Izod (notched)	ISO 180	kJ/m²	11.5
Charpy (notched)	ISO 179-1	kJ/m²	6
Charpy (unnotched)	ISO 179-1	kJ/m²	NB
ELEKTRISCH			
Eigenschaften	**Method**	**Unit**	**POLYCASA PETG POLYCASA PETG UV**
Dielectric constant 100 HZ	IEC 250		2.6
Volume Resistivity	ASTM D257	Ω.cm	$\geq 10^{15}$
Surface Resistivity	ASTM D257	Ω	$\geq 10^{16}$
Dielectric strength	ASTM D149	kV/mm	16
Dissipation Factor (50Hz)	IEC 250		0.01

Remark: **These technical data of our products are typical ones; the actually measured values are subject to production variations**

6.2 Resistance to chemicals

PETG sheets are resistant to many chemicals.

But it is recommended to carry out pretests due to the influences of temperature and exposure time or addition of special additives to improve properties.

Tested chemicals are as follows:

Acetone	-	Glycols	+
Acids (weak solution)	+	Glycerine	+
Alcohols		Hexane	+
Ethyl	+	Methylenechloride	-
Isopropyl	+	Methylethylketone	-
Methyl	+	Mineral Oil	+
Ammonia (weak solution)	+	Paraffin	+
Benzene	-	Toluene	-
Carbon tetrachloride	-	Sodium Chloride (aq)	+
Chloroform	-	Sodium Hydroxide (aq)	+
Ethyl Acetate	-		

\- Attacked
\+ Not attacked

Please contact us for further advice.

6.3 Product range of POLYCASA PETG und POLYCASA PETG UV

POLYCASA PETG and POLYCASA PETG UV sheets are protected on both sides with a PE-film, except patterned sheets, which are only protected on the smooth underside. For special applications, we also offer special protection film systems, such as suitable in thermoforming process.It should be noted that the PE protective films are limited in their lifetime, for more information, please call our sales office.

Thickness range for:

▪ POLYCASA PETG	standard version from 0.80 mm up to 20 mm Standard thicknesses 0.8-1-1.5-2-3-4-5-6-8-10-12- 15 - 20 mm
▪ POLYCASA PETG UV version	From 1.50 mm up to 12 mm Standard thicknesses 1.5 - 2-3-4-5-6-8-10-12-15-20 mm

For special thicknesses please call our sales office.

Widths cut on line

▪ Max 1250 mm	for 0.8 and 6.0 mm
▪ Max 2050 mm	from 1.5 mm up to 20 mm

Standard lengths cut on line

▪ 2050 mm	for thicknesses < 1.5 mm
▪ 3050 mm	for thicknesses > 1.5 mm (over lengths on special request)

Thickness tolerances

▪ 0.8 mm - 2.9 mm	± 10%
▪ 3.0 mm up to 20 mm	± 5%

Cut on line tolerances for standard sizes

▪ > 1000 mm	- 0 + 3‰ (3 mm per 1000 mm)
▪ < 1000 mm	on application

Cut to size tolerances

▪ For length and width	
▪ till 1000mm	-0 / + 1,0 mm
▪ from 1001 to 1500mm	-0 / + 1,5 mm
▪ from 1501 to 2000mm	-0 / + 2 mm

Minimum production runs for

▪ special thicknesses in clear	3.000 kg/5.000 kg/12.000kg (depending on extrusion line)
▪ special pattern or surfaces	5.000 kg
▪ special colours	10.000 kg

Shrinkage

▪ Thickness 1.5 - 2.5 mm	max. 6%
▪ Thickness 3.0 - 20.0 mm	max. 3%

Other thicknesses, sizes and tolerances on request.
For the standard stock programme see our product selector brochure.

7. USER GUIDE

7.1 Introduction

The manufacture of plastic articles from POLYCASA PETG and POLYCASA PETG UV sheet normally involves secondary fabrication operations, including sawing, drilling, bending, decorating, and assembling. This guide covers the properties and characteristics of POLYCASA PETG and POLYCASA PETG UV that need to be taken into account if secondary operations are to be performed successfully.

7.2 Storage and Handling

The originally packed plastic sheets should neither be stored outside nor be exposed to great variations of weather and/or temperature.
When storing under conditions with substantial variation of temperature and humidity, flat shape distortion (corrugation) of the sheet can happen, even when stored flat and stacked.

Polyethylene film protects sheets against dirt, mechanical load and scratches. It is recommended to leave the protective PE film in place until final processing.

Please do not store the sheets near heat sources.
The film has a restricted life-time and weathering and temperature resistance are limited.
If sheet is stored inside under normal stable storage conditions, it is recommended to remove the film 6 months after film application latest.
The sheets could be masked with special films, maybe for thermoforming processes or other specialties.
Details regarding suitability and processing properties can be obtained from technical customer service.

Depending on storage and climatic conditions, plastic sheets absorb moisture. Although humidity absorption has no practical influence on the physical properties.

Differences in temperature and moisture-content between top- and bottom-side of sheet or between different sheet areas can cause different dimension changes inside the sheet. This can result in waviness of the sheet after a short time. It is recommended to store the sheet under constant temperature- and humidity-conditions on a flat surface.

7.3 Material preparation

7.3.1 Cleaning

Protection film removal will induce a build-up of the electrostatic charge on the sheet surface. This electrostatic charge attracts airborne dust, and other fine particles.

Therefore, prior to further processing, it is recommended to clean the sheet by antistatic treatment (e.g. blowing by ionised compressed air or cleaning by hand with a cloth wetted with suitable antistatic agents.

This is particularly important prior to thermoforming process, as dust or dirt particles will cause imprints on the moulded surface.

Plain water will suffice for both cleaning and care of the sheets.

In case of excessive dirt, clean with warm water and a weakly alkaline, non-abrasive cleaning agent.

The sheets should be dried with a soft cloth or with chamois leather.

Dry scrubbing of the surface will cause scratches and possible damage.

Remove dust and dirt with a soft cloth and a solution of mild soap or liquid detergent in water. A 1:1 solution of isopropyl alcohol and water also works well.

Remove grease and residue from tape or paper masking with naphtha followed by a water wash.

Always use soft, damp cloth, rubbing with a dry cloth can scratch the material and create a static charge.

Never use scrapers or squeegees.

Also, avoid scouring compounds, gasoline, benzene, acetone and carbon tetrachloride, de-icing fluids, lacquer thinner or strong solvents.

Test commercial cleaning to ensure there is no adverse effect on the sheet.

The use of commercial cleaners should be in strict compliance with the manufacturer's instruct.

7.3.2 Drying

POLYCASA PETG und POLYCASA PETG UV sheets do not need to pre-dry before warm forming.

7.3.3 Dimensional Change

There are substantial orientation forces involved in the extrusion process to form the sheet from the molten polymer. A part of these forces remains "frozen" in the sheet.

When the sheet is to be heated e.g. before thermoforming, this stress became apparent in shrinkage of the sheet.

Such dimensional change has to be taken into consideration when cutting sheets to be thermoformed.

The shrinkage is always higher in parallel to the extrusion direction. Longitudinal shrinkage is always higher in thin sheets and lower in thick sheets.

When the material is heated and fixed in a clamping frame, no material shrinkage will arise.

As the shrinkage value depends on both heating temperature and heating time, preliminary tests are advisable.

Maximum longitudinal shrinkage values of POLYCASA PETG safely comply with Din EN ISO 11963:2013 Annex A, as follows

Sheet Thickness	**Amount of shrinkage**
1.50 mm up to <2 mm	≤15%
2.00 mm up to <3 mm	≤12%
3.00 mm up to 25 mm	≤7%

7.3.4 Thermal Linear Change

Like nearly all materials, POLYCASA PETG is subject to linear change at variable temperatures. Plastics show higher linear change than metals, and this must be taken into account when mounting POLYCASA PETG sheets into frames.

Material	**α [mm/m•K]**
POLYCASA PETG	0,068

When mounting POLYCASA PETG sheets, attention must be paid to the elongation clearance in order to avoid damage during material usage. For more technical data - see chapter „7.8 Glazing".

7.3.5 Dimensional change effected by moisture content

POLYCASA PETG absorbs moisture during storage and application. Beyond the thermal linear change, the content of moisture can effect an additional dimensional change. When mounting POLYCASA PETG sheets, attention must be paid to the elongation clearance in order to avoid damage during material usage.

Variation and differences in moisture content between interior and outside surface of a sheet effect different elongation between the sheet surfaces. This difference can cause curvature of the mounted sheet. This curvature can be avoided by choosing an applicable higher thickness of sheet, in order to get inherent stability. Preliminary tests are recommended.

7.3.6 Flatness

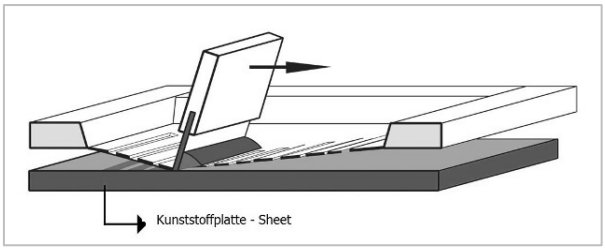
With increasing thickness extruded POLYCASA PETG sheets can show a slight deviation in flatness due to the cooling behaviour of the material.

Flatness is determined on a cut-to-size sample 1000 x 1000 mm.

Thickness	**Planarity**
≤ 10 mm	≤ 2mm
> 10 mm	≤ 3 mm

7.4 Surface Treatment

7.4.1 Printing



Silk-screen printing is the most commonly used method for printing POLYCASA PETG and allows the creation of a wide range of graphics.
Distortion screen printing allows the flat sheet to be formed after printing into a three dimensional article with correct print register. Allowance must be made for "stretching" of the image when designing the graphics.
Halogen spotlight systems should not be used when thermoforming printed sheets.

During the silk-screen print process, the high-viscous ink is pushed through a photo chemically pre-treated screen print fabric (polyamide or polyester) by mechanical action or by means of a hand-operated scraper. The ink is transferred to the sheet beneath the screen fabric.
In order to avoid stress cracking of POLYCASA PETG, only compatible inks must be used. The lacquer systems must be suitable for the intended application. Where necessary the sheet has to be tempered, pre-dried or cleaned before application of ink, to avoid stress cracks and adhesion problems. Preliminary tests are recommended.
Addresses of appropriate ink suppliers can be obtained from the Technical Service Department upon request.
Spray painting is another popular method for decorating sheet after moulding. Only ink or paints suitable for use with PETG sheets should be used.
POLYCASA Lenticular sheets , on one surface structured with a special lenticular screen in 60 LPI , 75 LPI or 100 LPI, are made from PETG Spectar raw material. The sheets are excellent suitable for off - sett printing or digital printing.
Further technical information can be found in our product guide POLYCASA LENTICULAR.

7.4.2 Laminating

The application of decorating foils or self-adhesive lettering or transfers is only suitable for flat or slightly curved sheets. Care should be taken that adhesive foils are used which not produce stress cracking of POLYCASA PETG sheets.

Evaporation may cause partial separation of the self-adhesive film; therefore POLYCASA PETG sheets should be pre-dried overnight at a temperature of 60°C.

Impurities such as dust particles can also lead to partial foil removal, which will impair the appearance of the lamination.

Where necessary the sheet has to be tempered or cleaned before application of ink, to avoid stress cracks and adhesion problems. Preliminary tests are recommended.

7.5 Fabricating

7.5.1 Machining guidelines

POLYCASA PETG and POLYCASA PETG UV sheet can be worked with most tools used for machining wood or metal. Tool speeds should be such that the sheet does not melt from frictional heat. In general, the highest speed at which overheating of the tool or plastic does not occur will give the best results.

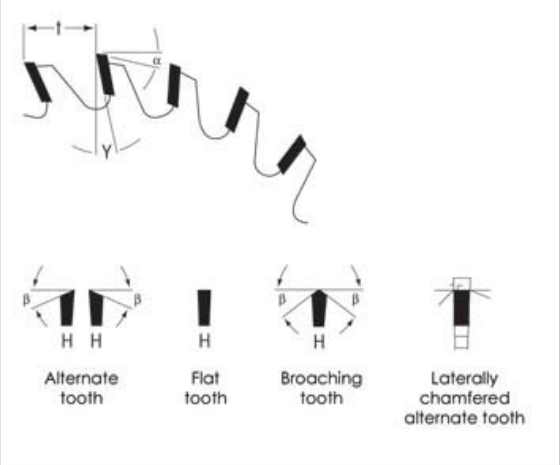
It is important to keep cutting tools sharp at all times. Hard, wear-resistant tools with greater cutting clearances than those used for cutting metal are suggested. High-speed or carbon-tipped tools are efficient for long runs and provide accuracy and uniformity of finish.

Since plastics are poor heat conductors, the heat generated by machining operations will be absorbed by the tool. A jet of air directed on the cutting edge aids in cooling the tool and in removing chips.

The protective film on POLYCASA sheets should not be taken off during handling and machining in order to prevent scratches or damaging the surface of the sheet. Machining of plastic materials will result in stress build-up in the material. For applications where the treated surface is in contact with active solvents e.g. decorating and cementing, it is recommended to anneal the parts prior to this secondary step.

7.5.2 Sawing

Figure 2: Example of Sawblades



Many types of sawing operations can be used to cut PETG sheet: band saw, circular saw and jigsaw as well as hand operated saws.

It is recommended that new or well-sharpened tools are used.

At very high cutting speeds, the saw blade should be cooled with a jet of air.

The total height of a sheet stack has to be considered. A high sheet stack could lead to overheating of the edges resulting in poor sawing edges or slight welding of the sheets. Rubbing surface of the saw blade in the product is low when the excess length of the saw blade will not exceed 5mm above the top PETG sheet in the stack.

The saw blade must be kept sharp to avoid melting and flaking of the sheet edges.

Table 1
Sawing Recommendations

Type of sawing	Band saw	Circular saw
Tooth distance	sheet thickness below 3 mm, 1 to 2 mm	8 to 12 mm
	sheet thickness 3 to 20 mm, 2 to 3 mm	8 to 12 mm
Clearance angle α	30 to 40°	15°
Rake angle Ψ	15°	10°
Tooth angle β	-	15°
Cutting speed	1200 - 1700 m/min	2500 - 4000 m/min
Feed speed	-	20 m/min

NOTE:
When sawing, be sure to hold or clamp the part securely to prevent it from cracking or slipping and presenting a safety hazard to the operator.

7.5.3 Drilling

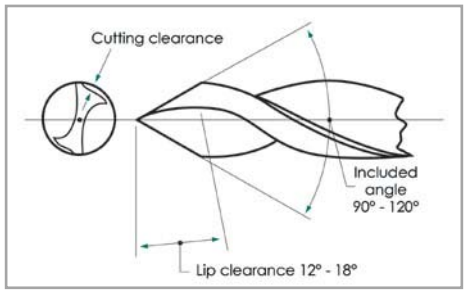


Figure 1
Suggested Drill-point Design for Drilling Plastic sheet

Drills designed especially for plastics are available, and their use is suggested. Standard twist drills for wood or metal can be used; however they require slower speeds and feed rates to produce a clean hole. Twist drills for plastics should have 2 flutes, a point with an included angle of 90° to 120°, and a lip clearance of ~30°; as shown in Figure 1.

Wide, highly polished flutes are desirable since they expel the chips with low friction and thus tend to avoid overheating and consequent gumming. Drills should be backed out often to free chips, especially when drilling deep holes. Peripheral speeds of twist drills for POLYCASA PETG ordinarily range from 10 to 60 m per minute. The rate of drill feed into the plastic sheet generally varies from 0.10 to 0.50 mm per revolution.

NOTE:
When drilling, be sure to hold or clamp the part securely to prevent it from cracking or slipping and presenting a safety hazard to the operator.

7.5.4 Thread cutting

Conventional 4-flute taps can be used for cutting internal threads in plastic sheet when a close fit is required. Such taps, however, have a tendency to generate considerable heat during the tapping operation. A high-speed, 2-flute tap should offer longer life and greater tapping speed than a conventional tap, as well as provide clearance for chip discharge. Flutes should be ground so that both edges cut simultaneously; otherwise the thread will not be uniform. Cutting edges should be 85° from the centre line, giving a negative rake of 5° on the front face of the lands so that the tap will not bind in the hole when it is backed out. It is desirable to have some relief on the sides of threads. The pilot hole must be 0.1 mm bigger than for steel. When tapping POLYCASA PETG it is recommended that the used coolants to be tested before in contact with PETG.

7.5.5 Milling

POLYCASA PETG and POLYCASA PETG UVP can be machined with standard high-speed milling cutters for metal, provided they have sharp edges and adequate clearance at the heel.

Universal, profile, spindle moulding and hand milling cutters at cutting speeds up to 4500 m/min can be used for milling POLYCASA PETG sheets. Small tool diameters require the application of one or two-edged milling cutters. They offer perfect removal of chips, high cutting speed and an excellent milling pattern.

When using one-edged milling cutters, the clamping chuck must be carefully tightened to avoid component marks on the sheet.

Cooling is not always required when milling POLYCASA PETG sheets with one or two-edged end mills, as they produce less heat than multi-edged end mills.

End milling of POLYCASA PETG- und POLYCASA PETG UVP sheets are possible with considering the following recommendations:

Diameter of the end miller	4 - 6 mm
Feed rate	ca.1.5 m/min
Rotation/min	18 - 24.000

7.5.6 Laser Cutting

POLYCASA PETG can be cut by laser beam in thicknesses up to 4.7 mm. A laser may be used to make intricate holes and complex patterns, or it can be controlled to merely etch the plastic.

Holes and cuts produced by a laser have a slight taper; the cuts are clean and precise, with finished appearance. Tolerances can be controlled more closely with a laser than with conventional machining operations. Laser power and travel speed must be optimised to minimise 'whitening' of the POLYCASA PETG while cutting.

High temperature of the laser cutted edges requires a cooling time of min. 30 minutes for relaxing the chemical structure of the sheets. Immediate further processing steps could induce cracking and breakage

7.5.7 Water Jet Cutting

Similarly to laser cutting, the possible cutting speed depends on both thicknesses of the material to be cut and desired cutting quality. Unlike laser cutting, the cut edges look "sand-blasted" as a result of water jet cutting. No thermal stresses occur in the material when using water jet cutting technique.

The water used for cutting POLYCASA PETG sheets contains abrasive additives.

7.5.8 Polishing

Mechanical polishing

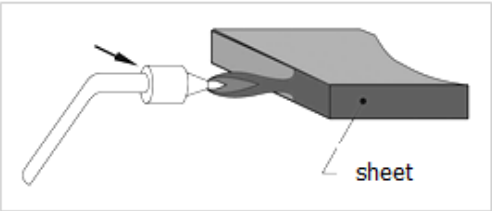
After grinding, surfaces of POLYCASA PETG can be polished in order to obtain a high surface finish. Burnishing wheels of cloth or fleece and felt polishing bands, together with a suitable polishing wax, give good results. Experience has shown that material surface temperatures should not be allowed to increase too much, as these can be responsible for a later appearance of fine cracks.

Diamond polishing

POLYCASA PETG can be diamond polished resulting in an excellent surface quality that does not need further treatment. No pre-grinding step is required prior to the polishing step with a diamond tool.

Flame polishing

POLYCASA PETG can be flame-polished using a standard propane torch or a Hot Nitrogen Welder. Both techniques require accurate control of the distance between the sheet and the heat source, otherwise surface whitening or excessive material flow will occur. A heat gun can be used to remove scratches from POLYCASA PETG. A gun with a temperature range of about 400° to 540°C, should be held about 100 mm from the scratch for approx. 5 seconds. The time may vary according to the severity of the scratch.



It is important to keep the flame moving and not to dwell on one spot.

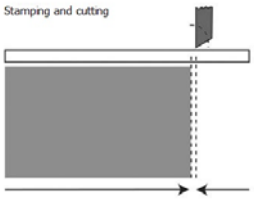
Solvent polishing

The appearance of saw-cut edges can be improved by first sanding and then solvent polishing with MEK or methylene dichloride. It may be necessary to add a slow drying component such as diacetone alcohol to prevent humidity blush after drying. Complete removal of all surface scratches and edge sand marks is not likely with solvent polishing since POLYCASA PETG has good chemical resistance.

NOTE:
When using solvents, proper ventilation of the area is essential. Follow all precautions listed on the Material Safety Data sheet supplied with the solvent being used.

7.5.9 Stamping and cutting

It is possible to stamp out POLYCASA PETG sheets up to about 2 mm thick, using normal, but very sharp metalworking tools, a cutting gap of 0,025 mm is recommended.
For thicker materials (up to 5 mm maximum), it is recommended to contact the POLYCASA technical service department for further advice.

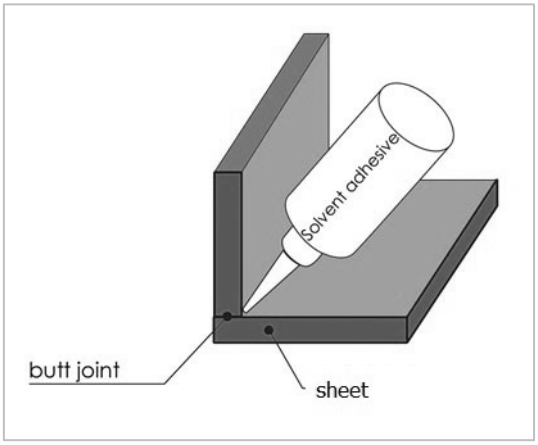


7.6 Assembly

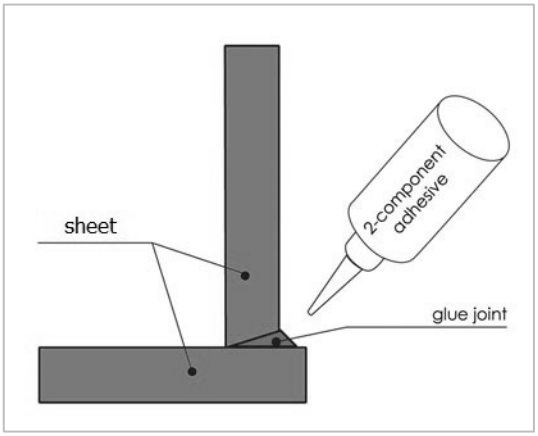
7.6.1 Bonding

The joint faces must be cleaned prior to bonding. Use warm water containing some washing-up liquid, if necessary; dry with an absorbent, lint free fabric (e.g. glove material). Highly greasy or oily surfaces can be washed with cleansing petrol.
The components to be bonded should be tempered to release stresses prior to bonding in order to avoid potential stress cracking (crazing) due to the reaction with the solvent glue; this applies especially to components having been machined by metal-cutting tools or cut by laser.

Solvent adhesives are particularly suitable for small and plane bonding surfaces. As the solid content of such glues is low, they have no joint filling capability. When bonding the sawn edge, smoothing the surface to be bonded using sharp edge scraper can reduce possible bubble formation.
Immersion technique implies that the edge to be glued is dipped into solvent or solvent adhesive, which is poured approx. 1 mm high onto a glass or PE sheet; the parts are afterwards firmly jointed.
Capillary method offers a simple technique for jointing and fixing of the parts. Solvent adhesive/solvent, is applied onto the bonding surface by means of a PE-vial and is soaked into the glued seam due to the capillary effect; a few seconds later, the joint should be firmly pressed together to set the joint.



Polymerisation adhesives are also suitable for large and uneven bonding surfaces. Planar bonding is possible.



The pasted seam must be prepared by chamfering; this does not apply to butt joint bonding. The adjacent sheet area must be masked with an adhesive compatible tape. The adhesive must be mixed as prescribed by the adhesive supplier. Removal of bubbles in vacuum is possible.
The adhesive must be applied bubble-free by means of a PE-vial or a disposable syringe. Excess adhesive must be provided, as the polymerisation adhesive exhibits volume shrinkage during curing.

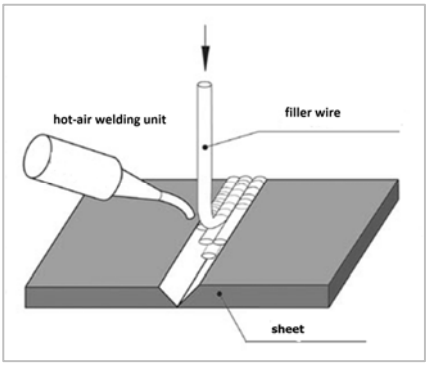
Silicones are often used to seal glazing. For this purpose, only silicones compatible with PETG must be employed. Silicone sealants as found in DIY centres, give off substances during curing which will result in stress cracks of the glued components.

Our technical service department will provide you with information on appropriate products.

POLYCASA PETG

7.6.2 Welding

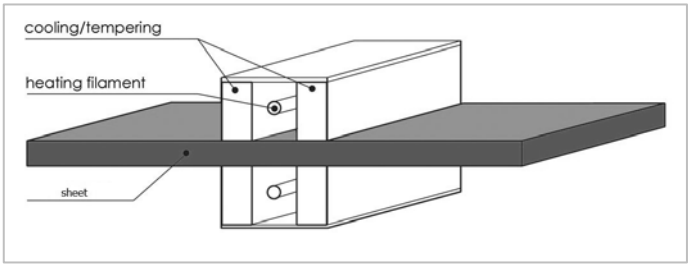
Hot-air welding with a filler rod is a possible welding technique used for POLYCASA PETG and PETG UV sheets. The welding temperature should be 120C° to 160°C.
Welding techniques should be preferred where the weld area is completely treated, e. g.. friction welding or hot-plate welding are suitable for flat welds.
When using hot air welding it is mandatory to pre dry the sheet and the filler wire 12 hours at 60°C to avoid moisture bubbles in the welding area.



7.7 Forming

Note!
Before thermoforming and hot bending of POLYCASA PETG we recommend removing the protective film, except the sheets with the special film for thermoforming.

7.7.1 Hot bending



POLYCASA PETG and POLYCASA PETG UV sheet can be bent to a small radius by preheating an area on both sides with an electric strip heater and then quickly bending the sheet along the heated line. When the optimum sheet temperature is reached (slightly over 105°C) and a slight resistance to bending is noticeable, the part can be readily formed. Pre-drying is only necessary if bubbles appear in the sheet bending zone. If bending is performed too cold, stresses will be created that will result in a brittle part.

7.7.2 Cold folding

Cold folding is possible in exceptional circumstances and should be carried out with regard to the following guidelines, using the normal bending machines available from trade suppliers. The bending should take place in several steps, e.g. in 30° intervals such as 40°, 70°, 100° and 120°. Hot bending gives much better results.

Sheet thickness in mm	Bending radius in mm	Max. bending angle
1; 2; 2.5	2	90°
3; 4	3	90°

7.7.3 Thermoforming

There are a number of different thermoforming techniques that can be used to form POLYCASA PETG and POLYCASA PETG UV sheet, once heated, into the shape of a mould by mechanical, air pressure, or vacuum forces. Both male (plug) and female (cavity) moulds are used. The required temperature for thermoplastic forming of POLYCASA PETG and POLYCASA PETG UV sheets lies between 105° and 150°C. Because of the high heat drop, surface temperature to room temperature, it is recommended that the sheets are heated on both sides, for which a total IR radiation power of 30KW/m^2 will achieve good results. For the continuous production of mouldings made from POLYCASA PETG sheets, in most cases aluminium or steel are chosen as material for the moulds. Bringing the moulds up to the optimum working temperature is therefore necessary. Optimum surfaces in the freezing zone of POLYCASA PETG sheets are achieved with a mould temperature of about 45 – 55°C.

Depending on forming technique, a good surface quality can be attempted at a mould temperature in the range of 50°. When thermoforming POLYCASA PETG UV sheets, care is to be taken to ensure that the depth of draw ratio should not be more than 1:1.5 to guarantee sufficient UV protection under the terms of the warranty.

POLYCASA PETG does not need to be pre-dried prior to thermoforming.

7.7.4 Straight vacuum forming

Vacuum forming is the most versatile and widely used forming process. The equipment costs less and is simpler to operate than most pressure or mechanical techniques. In straight vacuum forming, POLYCASA PETG and POLYCASA PETG UV is clamped in a frame and heated. When the hot sheet is in an elastic state, it is placed over the female mould cavity. The air is then removed from the cavity by vacuum and atmospheric pressure then forces the hot sheet against the contours of the mould. When the POLYCASA PETG or POLYCASA PETG UV sheet has cooled sufficiently, the formed part can be removed. Thinning at the upper edges of the part usually occurs with relatively deep moulds and is caused by the hot sheet being drawn to the centre of the mould first. Sheeting at the edges of the mould must stretch the most and thus becomes the thinnest portion of the formed item. Straight vacuum forming is normally limited to simple, shallow designs.

See figure 3

7.7.5 Drape forming

Drape forming is similar to straight vacuum forming except that after the POLYCASA PETG or POLYCASA PETG UV sheet is framed and heated, it is mechanically stretched and a pressure differential is then applied to form the sheet over a male mould. In this case, however, the sheet touching the mould is close to its original thickness. It is possible to drape-form items with a depth-to-diameter ratio of approx. 4 to 1; however, the technique is more complex than straight vacuum forming. Male moulds are easier to build and generally cost less than female moulds; however, male moulds are more easily damaged. Drape forming can also be used with gravitational force alone. For multicavity forming, female moulds are preferred because they do not require as much spacing as male moulds.

See figure 4

POLYCASA PETG

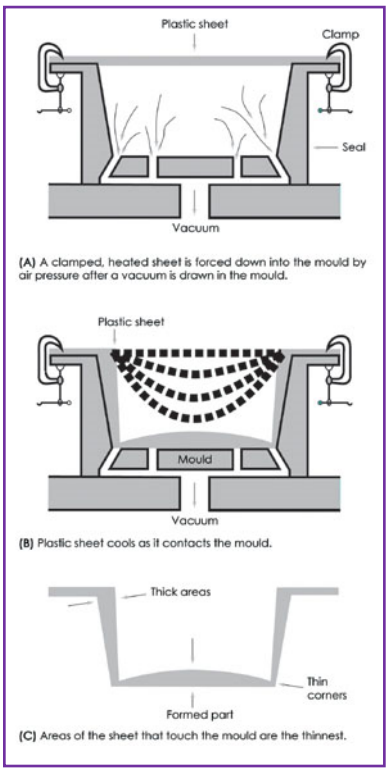


Figure 3
Straight Vacuum Forming

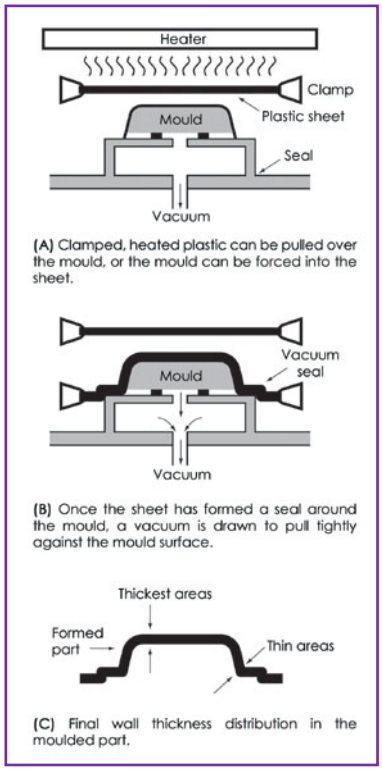
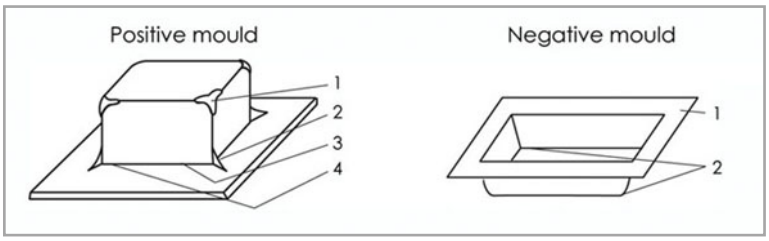


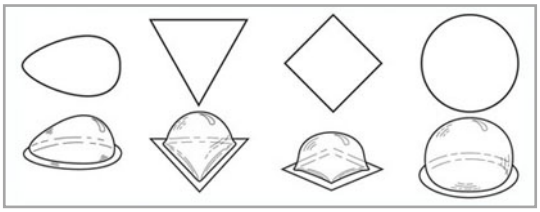
Figure 4
Drape Forming

Positive and negative forming



Dependent on whether the inside or the exterior of the mouldings contact the tool, the techniques are called “positive” or “negative” forming. Positive forming means that the heated semi-finished product is pulled over the mould. This is also known as “male” forming In doing so, some surface areas of the heated semi-finished products may excessively cool down, so that complete drawing is not feasible and “thick spots” will occur. Some typical problems during positive forming, such as wrinkle or web formation (2) and shock marks, can be solved by adequate pneumatic stretching prior to final “pull down. High tool temperatures and high tool speed can also cause shock marks. Negative forming means that the semi-finished sheet is drawn into the mould cavity. This is sometimes called “female” forming. Thin corner areas (2), which may appear during negative forming of sharp-edged components, can be reduced by mechanical top die stretching.

Procedure variant



Dome-shaped mouldings can be thermoformed without a mould. This method produces mouldings of good surface quality showing no optical defects. The dome form is determined by the clamping frame’s shape and the dome height by the blown air pressure.

7.7.6 Tempering

POLYCASA PETG is able to take up rather high tensile stresses, but only if corrosive substances do not simultaneously act upon the materials. Tensile stresses are induced by machining, laser-cutting, thermoforming, varying heating and external stresses, for instance. Tensile stresses expand the material structure thus reducing the resistance to environmental conditions. The effect of printing ink solvents, monomer vapours, sealing and foil plasticizers as well as inappropriate cleaning agents may result in crack formation. Crack formation will be excluded by stress free components. Therefore, generation of tensile stresses and contact with corrosive substances must be avoided.

As accidental contact with corrosives cannot be ruled out, tensile stresses must be avoided. Stress relief tempering of the parts can achieve reduction of internal stresses. External stresses must be excluded by using adequate fastening systems. Tempering of POLYCASA PETG should take place in heating cabinets with air circulation, at a temperature of 60 - 65°C. It is recommended to temper without protection film.

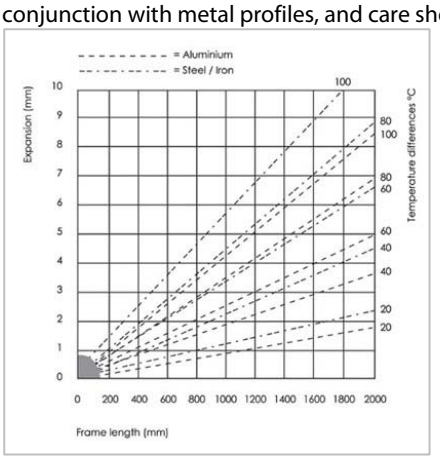
Material thickness (mm)	1.5	2	3	4	5	6	8	10	12	15	18	20
Tempering duration (h)	2	2	2	2	2	3	3	4	4	5	6	7

POLYCASA PETG sheets must be cooled down slowly to avoid repeated induction of the internal stress or moisture due to cooling down too fast after annealing. The maximum cooling speed after annealing has to be less than 10 °C per hour. The maximum oven temperature from which the material may be removed is 40°C.

POLYCASA PETG

7.8 Glazing

POLYCASA PETG and POLYCASA PETG UV sheets used in glazing applications result in considerable energy cost savings by preventing excessive heat loss in winter and by blocking heat entry in the summer. When processing POLYCASA PETG sheets with other materials, different rates of expansion on heating should be taken into consideration. POLYCASA PETG is frequently used in conjunction with metal profiles, and care should be given to allow sufficient room for expansion and contraction.



POLYCASA PETG expands under heat and moisture absorption and contracts in cold and dry weather. The linear change solely due to the change in temperature can be determined by calculating the coefficient of thermal expansion.

POLYCASA PETG shows a coefficient of thermal expansion of 0.068 mm/m•°C.

Example:

A square meter PETG sheet in 5mm will be mounted in an area with a temperature between -10°C and +60°C .

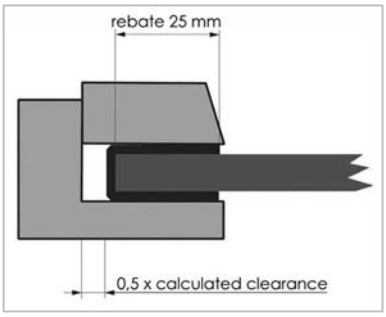
So a change of 60 °C has to be considered:

Calculation: 1,0 m x 0,068 mm/(m °C) x 60°C = 4,08 mm expansion

The linear change must be allowed during the sheet's storage time. The maximum expected value of linear deformation depends on the temperature used when mounting the sheets.

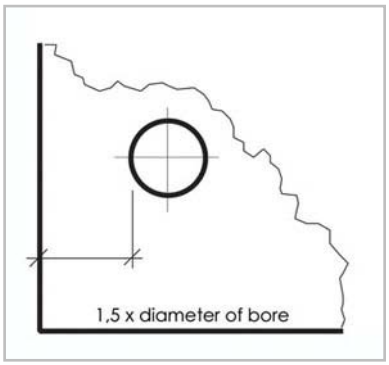
An adequate free space of 5 mm/m should be kept with POLYCASA PETG (guide value).

The rebate should be approx. 20 – 25 mm deep.



To achieve impermeability of glazing to rain water, only sealing agents shall be used which are compatible with extruded PETG sheet. Construction and sealing material must allow the movement of sheet inside the profiles due to dimensional changes of sheet. Profiled EPDM joints, preferably in white, have proven to be successful in heat loss avoidance. In most cases, profiled joints of non-rigid PVC and PUR foam are incompatible, due to the migration of plasticizers.

The drilled holes must be adequately dimensioned when fixing to specific points, in order to also allow for a sheet length clearance of 0.065mm/m•°C. In that case, sheet length is deemed to be the greatest existing distance between two holes. To avoid material breaking at the sheet edge, a distance of 1.5 times the diameter of hole must be left.



Avoid to strong fixing of the screws as well as tapered screw holes that expansion of the sheets is warranted during temperature changes

7.8.1 Vertical and horizontal glazing

Necessary thickness of glazing could be determined with below table. Thickness of the glazing primarily depends on the sheet size.

POLYCASA PETG (Thickness) ➔ 4-sided-clamped ➔ Load of 0,60 kN/m²

	Length (mm)									
	500	**1000**	**1500**	**2000**	**2500**	**3000**	**3500**	**4000**	**4500**	**5000**
Width (mm)	**500**	3	4	4	4	4	4	4	4	4	4
	1000	4	8	8	8	8	10	10	10	10	10
	1500	4	8	10	12	12	12	12	12	12	12
	2000	4	8	12	12	15	15				

POLYCASA PETG (Thickness) ➔ 4-sided-clamped ➔ Load of 0,75 kN/m²

	Length (mm)									
	500	**1000**	**1500**	**2000**	**2500**	**3000**	**3500**	**4000**	**4500**	**5000**
Width (mm)	**500**	4	5	5	5	5	5	5	5	5	5
	1000	5	8	8	10	1o	10	10	10	10	10
	1500	5	8	10	12	12	15	15	15	15	15
	2000	5	10	12	15						

POLYCASA PETG (Thickness) ➔ 4-sided-clamped ➔ Load of 0,96 kN/m²

	Length (mm)									
	500	**1000**	**1500**	**2000**	**2500**	**3000**	**3500**	**4000**	**4500**	**5000**
Width (mm)	**500**	4	5	5	5	5	5	5	5	5	5
	1000	5	8	10	10	10	10	10	10	10	10
	1500	5	10	12	12	15	15	15	15		
	2000	5	10	12	15						

POLYCASA PETG (Thickness) ➔ 4-sided-clamped ➔ Load of 1,50 kN/m²

	Length (mm)									
	500	**1000**	**1500**	**2000**	**2500**	**3000**	**3500**	**4000**	**4500**	**5000**
Width (mm)	**500**	5	6	6	6	6	6	6	6	6	6
	1000	6	10	10	12	12	12	12	12	12	12
	1500	6	10	15							
	2000	6	12								

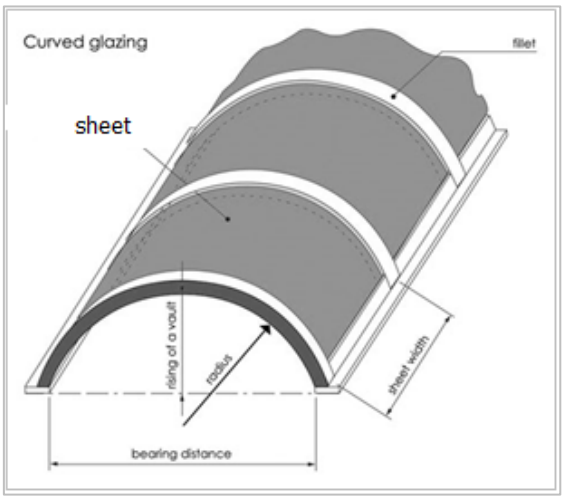
POLYCASA PETG

7.8.2 Barrel Vaults

POLYCASA PETG and PETG UV are suitable for cold bending technique. This method facilitates the application of thinner material gauges compared to plane roofing, as an increased self-rigidity of the sheet is achieved due to the change in geometry.

In order to exclude material damage caused by tension stress and environmental influences, the min. bending radius must not be less than 150 x the sheet thickness. As far as fixing and sealing are concerned, only materials not having corrosive (crazing) effect on POLYCASA PETG should be used.

For this type of application, we recommend taking note of the values in the following diagrams A-D.



Supporting bow spacing: max. 2000 mm; Average expansion level: 5 mm/m.

Example

With a supporting bow spacing of 1000 mm, diagram B would be used. For a loading of 700 N/m² and a bending radius of 2500 mm, a sheet thickness of 5 mm is obtained.

Diagram A

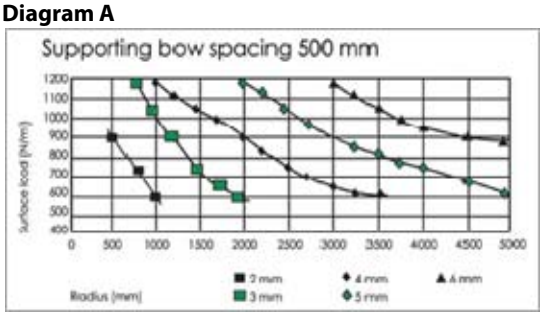


Diagram B

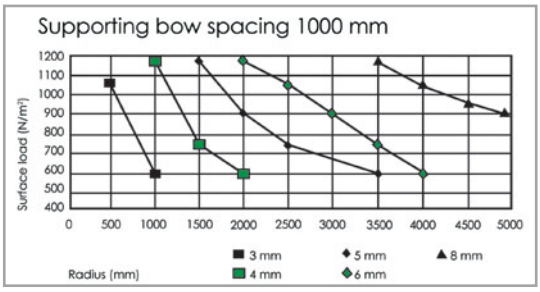
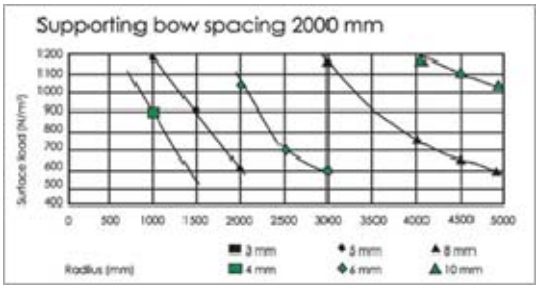


Diagram C

Diagram D



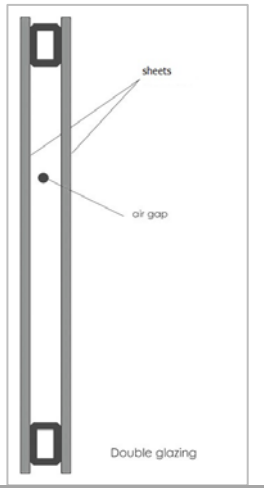
Information on recommended material thicknesses in case of various surface loads is available from our Technical Service Department upon request.

7.8.3 Thermal Insulation

POLYCASA PETG sheets when used for glazing represent considerable energy cost savings as they prevent excessive heat loss in winter and heat intrusion in summer. The heat loss factor of POLYCASA PETG normally referred to as K-value is significantly lower than for glass of the same thickness. The K-value is the parameter which identifies the heat loss of a building with glazed walls.

Definition: The K-value (U-value) identifies the heat loss in watt per m^2 wall surface and per °C difference in ambient temperature of premises separated by the sheet.

The K-value depends on the glazing assembly. Examples of the thermal insulation power of POLYCASA PETG in single, double and triple glazing systems are indicated below. Compared to glass, they show significant advantages as to insulating effect and weight reduction.



Installation			POLYCASA PETG		Window glass	
Sheet thickness (mm)	Air gap (mm)	Composite strength (mm)	U-Value (W/m²*K)	Weight (kg/m²)	U-Value (W/m²*K)	Weight (kg/m²)
Single glazing						
2	-	2	5.54	2.54	5.83	4.96
3	-	3	5.41	3.81	5.80	7.44
4	-	4	5.27	5.08	5.77	9.92
5	-	5	5.10	6.35	5.74	12.40
6	-	6	4.99	7.62	5.71	14.88
8	-	8	4.76	10.16	5.66	19.84
10	-	10	4.55	12.70	5.60	24.80
Double glazing						
2	5	9	3.34	5.08	3.55	9.92
2	10	14	2.94		3.10	
2	15	19	2.77		2.91	
3	5	11	3.23	7.62	3.53	14.88
3	10	16	2.85		3.09	
3	15	21	2.69		2.90	
4	5	13	3.12	10.16	3.50	19.84
4	10	18	2.77		3.07	
4	15	23	2.62		2.88	
5	5	15	3.02	12.70	3.48	24.80
5	10	20	2.69		3.05	
5	15	25	2.55		2.87	
Triple glazing						
2	2 x 5	16	2.39		2.55	
2	2 x 10	26	2.00	7.62	2.11	14.88
2	2 x 15	36	1.84		1.94	
3	2 x 5	19	2.30		2.53	
3	2 x10	29	1.94	11.43	2.10	22.32
3	2 x 15	39	1.79		1.93	
4	2 x 5	22	2.22		2.52	
4	2 x 10	32	1.88	15.24	2.09	29.76
4	2 x 15	42	1.74		1.92	
5	2 x 5	25	2.15		2.50	
5	2 x 10	35	1.83	19.08	2.08	37.20
5	2 x 15	45	1.70		1.91	

Information on further specific glazing systems can be obtained from our Technical Service Department upon request.

8. CONCLUDING REMARKS

For more details on further processing methods. please contact our technical customer service.

NOTE:

Our technical recommendations are without legal obligation.

The information given in this brochure is based on our knowledge and experience to date. It does not release the user from the obligation of carrying out own tests and trials. In view of the many factors that may affect processing and application; neither do they imply any legally binding assurance of certain properties or of suitability for a specific purpose.

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