POLYCASA HIPS

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1. PRODUCT IDENTIFICATION

POLYCASA HIPS is the brand name for extruded Impact Modified Polystyrene sheets made by POLYCASA.

The HIPS sheets typically have high impact strength and can be offered in a matt finish (FMM types) or in a gloss finish (FMG types) at the front side.
The high gloss effect is obtained through co-extrusion of a GPPS (general purpose polystyrene) layer on top of the HIPS. In addition to sanitary and standard colours, colour matching can be made to order.

2. CHARACTERISTICS

- Excellent low temperature high impact strength
- Smooth surface finish, either matt or glossy surface
- Smart, leather, grain and pinseal emboss available
- Extremely suitable for thermoforming applications
- Good electrical properties

3. APPLICATIONS

- Displays
- Screen printing
- Refrigerators
- Sanitary ware
- Mobile homes and caravan fittings
- Packaging

4. FABRICATION AND FINISHING TECHNIQUES

POLYCASA HIPS sheets are easy to handle.
POLYCASA HIPS is suitable for sawing, drilling, gluing, screen printing, milling/engraving and thermoforming.

5. STATEMENTS

5.1. Food approval statement

Our standard product types coloured, white and black are made from materials that allow for contact with foodstuffs except UV improved products.

Products are in compliance with FDA regulation and European frame work 1935/2004/EC including ordinance 10/2011 (former 2002/72/EC).

Certificates of Conformance can be supplied on request.

5.2. Fire classification

Europe

EN13501-1 (former DN 4102-1)	Euro class E (former B2)

5.3. Quality management

POLYCASA HIPS sheets are manufactured and audited for quality in compliance with the certified and regularly audited producction and quality management system according to EN ISO 9001:2008.

5.4. Product safety

Product handling information documents for HIPS sheets are available on request.

6. TECHNICAL INFORMATION

6.1. Technical data sheet

GENERAL				
Property	**Method**	**Unit**	**POLYCASA HIPS Glossy/Matt**	**POLYCASA HIPS Matt/Matt**
Density	ISO 1183	g/cm^3	1,05	1.05
Burning resistance	UL standard 94		94 HB	94 HB
MECHANICAL				
Property	**Method**	**Unit**	**POLYCASA HIPS Glossy/Matt**	**POLYCASA HIPS Matt/Matt**
Flexural modulus	ISO 178	MPa	1850	1800
Flexural strength	ISO 178	MPa	34	32
Tensile modulus	ISO 527-2	MPa	1730	1670
Tensile strength	ISO 527-2	MPa	24	20
Elongation at break	ISO 527-2	%	2.9	42
Stress at break	ISO 527-2	MPa	18	16
Ball indentation hardness	ISO 2039-1	N/mm^2	80	80
THERMAL				
Property	**Method**	**Unit**	**POLYCASA HIPS Glossy/Matt**	**POLYCASA HIPS Matt/Matt**
Vicat temperature (B 50)	ISO 306	°C	92	91
Heat deflection temp. (A)	ISO 75-2	°C	82	84
Linear thermal expansion	DIN 53752	$K^{-1}x10^{-5}$	8	8
Service temperature - continuous use	DIN 52612	°C	70	70
Thermal conductivity	ISO 11501	W/mK	0.16	0.16
Dimensional change on heating (4 mm)	ISO 14631	%	5	5.5
ELECTRICAL (raw material specifications)				
Property	**Method**	**Unit**	**POLYCASA HIPS Glossy/Matt**	**POLYCASA HIPS Matt/Matt**
Volume resistivity	IEC 93	Ωcm	$>10^{16}$	$>10^{16}$
Surface resistivity	IEC 93	Ω	$>10^{13}$	$>10^{13}$
Dielectrical strength	IEC 243-1	kV/mm	155	155
Dielectrical constant at 100Hz-1MHz	IEC 250		2.5	2.5
Dissipation factor at 100Hz-1MHz	IEC 250		10^{-4}	10^{-4}
IMPACT RESISTANCE				
Property	**Method**	**Unit**	**POLYCASA HIPS Glossy/Matt**	**POLYCASA HIPS Matt/Matt**
Charpy notched glossy side impacted	ISO 179-1/1fA	KJ/m^2	9	-
Charpy notched matt side impacted	ISO 179-1/1fA	KJ/m^2	6	10

Note: all mentioned data is based on extruded sheets in a thickness of 4 mm

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6.2. Product range POLYCASA HIPS

Standard Matt/Matt (FMM type)

On-line flat M/M	Minimum sheet size	Maximum sheet size		
Thickness in mm	0,50	0,50 – 1,49	1,50 – 6,00	6,01 – 10,00
Length in mm	1000	4000	6000	4000
Width in mm	500	1650	2050	1550

On-line patterns	Minimum sheet size	Maximum sheet size*		
Thickness in mm	1,00	1,00 – 1,49	1,50 – 6,00	6,01 – 10,00
Length in mm	1000	4000	4000	4000
Width in mm	500	1650	1650	1550

* Pinseal = max. width 2050mm

Standard product is supplied without protection foil: on request the sheets can be protected with PE glued foil on one or both sides.

Surface finish: FMM sheets typically have a matt surface finish with a gloss value between 10 and 25 units (measured at 60° according to ISO 2813). On request FMM sheets can be made gloss improved.

Available embossed surface: SMART, PINSEAL, LEATHER, GRAIN

Standard Matt/Gloss (FMG type)

Type	Thickness	Max. sheet width	Max. sheet length
Smooth	1,50 – 6,00 mm	2050 mm	6000 mm

Standard production sheets are protected with a PE thermo formable protection film on the glossy side only.

Surface finish: FMG sheets have a GPPS (general purpose polystyrene) layer with a gloss level of above 85 units (measured at 60° according to ISO 2813) on one side and on the other a matt HIPS finish. The gloss layer has a thickness of approx. 5-7% of the total sheet thickness.

Standard minimum sheet size

Minimum size for all sheets is: 1000 x 500 mm.

Colour range

A range of colours is available. Other shades can be matched using the latest state-of-the-art Spectrophotometer technology on customer request. For minimum quantities see further.

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Standard product tolerances

All sheets are made to size on-line by a knife or guillotine cut. This means no secondary cutting which could create marks during thermoforming or printing.

Flat sheets

- Thickness:
  - +/- 8% from 0.50 mm till 1.49 mm
  - +/- 0.1 mm from 1,49 mm till 3.99 mm
  - +/- 0.2 mm from 4,00 mm till 10.00 mm
- Length / Width:
  - +/- 1.5 mm for sizes up to 1000 mm
  - -0/+6 mm for sizes 1001 – 2000 mm
  - -0/+9 mm for sizes longer than 2000mm

Patterned sheets

- Thickness:
  - +/- 8% from 0.50 mm till 1.49 mm
  - +/- 0.1 mm from 1.49 mm till 3.99 mm
  - +/- 0.2 mm from 4.00 mm till 10.00 mm
- Length / Width:
  - +/- 1.5 mm for sizes up to 1000 mm
  - -0/+6 mm for sizes 1001 – 2000 mm
  - -0/+9 mm for sizes longer than 2000 mm

Other thicknesses, size and tolerances on request. For the standard stock program see our product selector.

Required minimum quantities

- Product type 5.000 kg
- Special colour 5.000 kg
- Special pattern 10.000 kg*
- Special thickness 3.000 kg*
- Special dimensions1.000 kg*

*For more details, please contact our sales dpt.

Return of off cuts

Special contracts can be established and agreed for the return of off-cuts.

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Special requirements

We can also deliver sheet designed for special applications. These possibilities include:

- ESCR (Environmental Stress Cracking Resistance) –
  Special grades for the refrigerator industries where the sheet must be resistant against aggressive blowing agents for the PU foam
- Improved UV resistance
- Corona treatment

For other specific requirements please ask our technical department for support.

We can also make samples available for testing at your facilities.

Notes

- All mechanical properties are based on extruded sheets in a thickness of 4 mm.
- The information provided above is correct to the best of knowledge, information and belief at the date of its publication. All information here is given without obligation and may be subject to change without prior information to all third parties. POLYCASA will not accept responsibility in case of damage or loss by use of these products and or above information.

7. USER GUIDE

7.1. Introduction

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

7.2. Fabricating

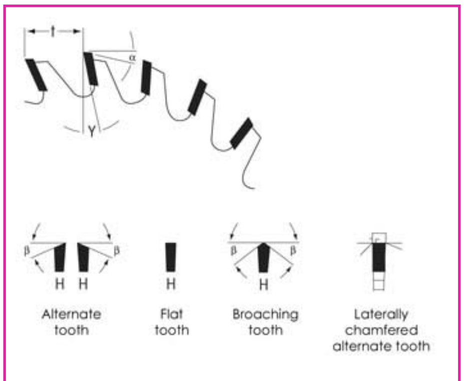
7.2.1. Machining guidelines

POLYCASA HIPS 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 must be absorbed by the tool or carried away by coolant. A jet of air directed on the cutting edge aids in cooling the tool and in removing chips.
Plain water or soapy water is sometimes used for cooling unless the trim scrap is to be reused.

7.2.2. Milling

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

7.2.3. Sawing



Following types of sawing operations can be used to saw thermoplastic materials: band saw, circular saw and jigsaw as well as hand operated saws.
It is recommended that new or well-sharpened tools be used. At very high cutting speeds, the saw blade should be cooled with water or an alternative appropriate cooling emulsion.

Example of Sawblades

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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 12 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	-	30 /min

7.2.4 Routing

Routers with sharp two-flute straight cutters produce very smooth edges. They are useful for trimming the edges of flat or formed parts, particularly when the part is too large or irregular in shape for a band saw. Portable, overarm, and under-the-table routers work equally well. The plastic sheet should be fed to the router slowly to avoid excessive frictional heating and shattering. The router or plastic sheet, whichever is moving, must be guided with a suitable jig.
Compressed air can he used during the routing operation to cool the bit and aid in chip removal.

7.3. Forming Information

There are a number of ways to achieve the finished shape, which include using vacuum pressure to *pull* the sheet into the mold, using air pressure to *push* the sheet into the mold or a combination of the above with a mechanical aid, known as a "plug" to help the sheet conform to the mold shape. The most appropriate method will be determined by the complexity of the article being formed and also the depth of draw in ratio to the surface area of sheet.

7.3.1. Heating

POLYCASA HIPS sheet must be heated properly to ensure optimum moulding performance. Thick sheets will require more heat than thin sheets, but careful control of the heating cycle is vital to avoid burning or degrading the surface of thicker sheet. Sandwich, or two sided, heating is essential for sheets over 2 mm thick to ensure that the sheet is heated evenly throughout and without causing the surface to become overheated. For sheets over 6 mm in thickness it is strongly recommended that pre-heating of sheet is carried out, which will also provide higher quality forming.

7.3.2. Thermoforming

Guidelines for processing POLYCASA HIPS

Sheet temperature	95-150°C
Mould Temperature	55-90°C
Demould	immediately after the part becomes cool
Shrinkage	0.5 – 0.6%

There are a number of different techniques used in thermoforming POLYCASA HIPS, but all use the same basic method of the application of heat and pressure to achieve a finished shape.

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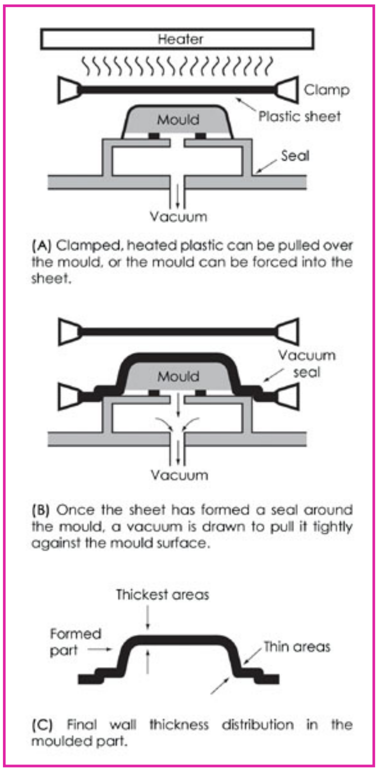
Thermoforming, sometimes known as vacuum forming, typically uses a clamp to hold sheet in place while it is heated and then, when softened, a mold is placed next to the sheet whilst the air is evacuated, by a vacuum pump. This causes the sheet to be forced into the shape of the mold, and once the sheet has cooled down, the finished article can be removed and worked on further as required.
This technique can be used to make articles as diverse as refrigerator liners, through to simple signs with limited depth.

7.3.3. Drape forming



Drape forming is similar to straight vacuum forming except that after the POLYCASA HIPS 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 multi-cavity forming, female moulds are preferred because they do not require as much spacing as male moulds.

7.3.4. Matched-mould forming

Matched-mould forming is similar to compression moulding in that heated POLYCASA HIPS sheet is trapped between male and female dies made of wood, plaster, epoxy or some other material.
Although they cost more, water-cooled matched moulds produce more accurate parts with close tolerances.

7.3.5. Pressure-bubble plug-assist vacuum forming

The pressure-bubble plug-assist vacuum forming technique can be used when POLYCASA HIPS sheet is to be formed into deep articles that must have good thickness uniformity. The sheet is placed in a frame and heated, and controlled air pressure is used to create a bubble. When the bubble has been stretched to a predetermined height, the male plug-assist (normally heated) is lowered to force the stretched sheet into the cavity. Plug speed and shape can be varied for improved material distribution; however, the plug is made as large as possible so that the plastic material is stretched close to the shape of the finished product. The plug should penetrate 75 to 85% of the mould cavity depth. Air pressure is then applied from the plug side while a vacuum assist is being drawn on the cavity. The female mould must be vented to allow the escape of trapped air.

7.3.6. Plug-assist pressure forming

Plug-assist pressure forming is similar to plug-assist vacuum forming in that a plug forces the hot POLYCASA HIPS sheet into a female cavity. Air pressure applied from the plug then forces the plastic sheet against the walls of the mould. Plug design and plug speed can be varied to optimize material distribution.

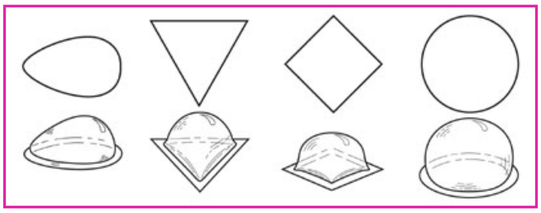
7.3.7. Plug-assist vacuum forming

Corner or periphery thinning of cup- or box-shaped articles can be prevented by use of a plug-assist to mechanically stretch and pull additional plastic material into the female cavity. The plug should be 10 to 20% smaller than the mould and should be heated to just under the forming temperature of the sheet. Once the plug has forced the hot sheet into the mould cavity, air is drawn from the mould to form the part.

Plug-assist vacuum forming and plug-assist pressure forming (see previous section) allow deep drawing and permit shorter cooling cycles and good wall thickness control. Both processes require close temperature control and are more complex than straight vacuum forming.

7.3.8. Free forming

In free forming, air pressures of about 2.76 MPa can be used to blow a hot POLYCASA HIPS sheet through the silhouette of a female mould. Air pressure causes the sheet to form a smooth bubble-shaped article. Since only air touches each side of the pad, there will be no mark-off unless a stop is used to form a special contour in the bubble



7.3.9. Demoulding

Once formed into the correct shape the part must be cool enough to be removed from the mould, without losing its shape, or sticking. The sheet needs to be at least 10°C below the Vicat softening point of the sheet, to allow the part to become rigid enough to withstand handling. Sufficient time must be allowed, as cooling sheet too rapidly can cause thermal stress, with consequent loss of physical properties

7.3.10. Finish Trimming

Once the part has cooled and been removed from the forming equipment, it is usual for the edge of the sheet to be trimmed off, leaving the finished part ready for subsequent work. Depending on volumes of parts, trimming can be done with shears, band saws or routing machines, or for large volumes it may be necessary to use clicking presses, machined cutting forms or steel rules, to speed the process.

7.4. Assembly

POLYCASA HIPS sheet can be fabricated into a variety of shapes and articles with solvent, cement (a polymer dissolved in a solvent), or adhesive bonds. In general, when the surfaces to be joined are irregular, a cement is preferred over a solvent.
Solvents and cements are not the best choice when bonding POLYCASA HIPS sheet to other thermoplastics. Adhesives, including cyanoacrylates, two-part acrylics and hot melts, are more effective when bonding POLYCASA HIPS to dissimilar plastics and can be used to bond POLYCASA HIPS to itself.

7.4.1. Assembly guidelines

The following guidelines should be observed when bonding POLYCASA HIPS sheeting:

- The sheet edges must be clean and free from contamination.
- The surfaces must be smooth and accurately aligned.
- A solvent or cement must be sufficiently active to soften the mating surfaces for some flow to occur when pressure is applied.
- When using solvents in POLYCASA HIPS sheet assembly, it is advisable that the work area be climate controlled with low humidity to minimise joint 'whitening'. If this is not possible, the addition of 10% glacial acetic acid to the solvent or use of a slower curing cement-type bond is suggested.
- Fixture pressure must be maintained to prevent movement of the joint until it is solid.
- Good ventilation is required when working with solvents. Exposure levels must be controlled according to OSHA guidelines.

7.4.2. Bonding techniques: solvents, cements and adhesives

Small articles with flat surfaces can be joined by placing the pieces together and applying the appropriate bonding agent (solvent, cement, or adhesive). Care should be taken to ensure that the joints are uniformly coated; a solvent can be effectively applied with a needle applicator. The assembly should be clamped into position until the bond is set. When larger articles are to be solvent bonded, it is best to immerse the joining surfaces in a solvent bath until the material is softened and then clamp them into position until the bond has set. A constant level of solvent immersion should be maintained in a shallow pan with a support pad, screens, and other means to ensure part-to-part uniformity.
Several solvents, cements, and adhesives provide strong bonds when used in POLYCASA HIPS sheeting fabrication operations:

Material	**Bond type**
Methyl Ethyl Ketone (MEK)	Solvent
Methylene Chloride	Solvent
Mixture of PS in a 50/50 mixture toluene/MEK (300g PS/1000g mixture)	Solvent
Super Glue	Cyanoacrylate Adhesive

7.5. Finishing

7.5.1. Sanding

POLYCASA HIPS sheet is best sanded wet to avoid the frictional heat build-up that is characteristic of dry sanding techniques. If water coolants are used, the abrasive lasts longer and the cutting action increased. Progressively finer abrasives are used: for example, rough sanding with 80-grit silicon-carbide would be followed by finer sanding with 280-grit silicon-carbide, wet or dry. The final sanding may be with 400 or 600-grit sandpaper. After the sanding is finished and the abrasives removed, additional finishing operations may be required.

7.5.2. Joining

A standard woodworking jointer-planer will produce an accurately aligned and good quality finished edge on POLYCASA HIPS sheeting. Carbide or high speed blades, which have a longer life, will provide a uniform finish as well.

7.5.3. Filing

When many thermoplastics, including POLYCASA HIPS, are filed, a light powder that tends to clog some files is produced. Therefore, aluminium Type A, shear-tooth, or other files that have coarse, single-cut teeth with an angle of 45° are preferred.

7.5.4. Printing

POLYCASA HIPS sheeting can be printed with conventional equipment; however, the ink does not penetrate a plastic as it does with paper and cloth and is therefore subject to damage by abrasion. Abrasion can be minimised by applying a light coat of clear lacquer over the printing.

Ink adhesion is linked to surface tension, which can be increased by corona treatment. Level of surface tension exceeding 40DYN and will not last earlier than 3months after production can be offered on request.

There are a number of different methods used when printing on plastics including letterpress, letter flex, dry offset, offset lithography, rotogravure, stencilling, and screen process. In silk screening, the ink is spread on a fine metallic or fabric screen onto the product, and a squeegee is used to force the ink through the screen on the sheet.

Since each application may require a different type of ink, it is suggested that an ink manufacturer be consulted for recommendations.

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 their 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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