IşıkPlastik

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Policam

Polycarbonate Solid and Multiwall Sheet Fabrication Guide

1. PRODUCT IDENTIFICATION

Policam™ is the brand name of industrial extruded sheets manufactured by Işık Plastik A.Ş. This Fabrication Guide is published to explain and to offer solutions regarding fabrication details of Polycarbonate Solid and Multiwall Sheets for indoor and outdoor applications. You can contact with Işık Plastik for more information if needed.

Polycarbonate is mainly a really tough and transparent thermoplastic material with a wide range of usability in lots of sectors in the market. Polycarbonate can be fabricated & formed in practically any available industrial process like extrusion and thermoforming. The UV-resistant surface treatment on one side of the polycarbonate sheet significantly improves long-term weatherability. Policam™ Polycarbonate Solid and Multiwall Sheets are produced with a UV-resistant layer at one side. Also we can produce UV-resistant layer at both sides of the sheet on request.

Some properties of polycarbonate can be summarized as follows:

- extraordinary strength & impact resistance
- excellent toughness
- glass like transparency & light transmission
- high flexibility
- relatively high working temperature range
- very high heat resistance
- fair chemical resistance
- excellent workability & fabrication qualities.

Some other engineering applications can be listed as follows:

- equipment housings
- exterior automotive components
- outdoor lighting fixtures
- nameplates and bezels
- non-automotive vehicle windows
- brackets and structural parts
- medical supply components
- plastic lenses for eyeglasses

Polycarbonate Solid Sheet

Işık Plastik offers flat solid polycarbonate sheet in different configurations such as transparent & translucent. Işık Plastik can meet customer expectation in any specifications of color, light transmission and heat reflection requirements with best quality.

Işık Plastik supply sheets with co-extruded UV protective layer on its both sides which to be applied in open outdoors glazing, with possible UV exposure on both sides and external artificial lighting elements and also diffuser specialty.

Properties and possible applications listed below.

Properties of Işık Plastik Policam Solid Polycarbonate Sheets

- very high impact resistance.
- %88 light transmission.(Depends on sheet thickness)
- B s1 d0 (up to 6 mm)/Class 1Y/UL 94 HB fire resistance certified.
- excellent thermoforming capabilities
- outstanding weatherability
- easily fabricated
- can be cut with a shear
- excellent resistance to dilute acids and mineral oils.
- suitable for food contact (non-UV treated)

Possible Applications of Işık Plastik Policam Solid Polycarbonate Sheets:

- building windows
- light-transmitting roof cover and glazed curtain walls
- natural sunlight construction equipment in roofs and walls (Skylights, sidelights)
- transparent indoor applications as partitions and rooms
- noise barriers on side of roads & highways and noisy public places such as stadium & sport centers , arenas, fitness centers, schoolyards etc.
- instrumental panel display screens, backlit signage and displays, graphic overlay panels, illuminated menu boards and vending machine graphics, point-of-purchase posters, retractable banner stands, tradeshow booth panels, transit advertising and bus shelter advertising.
- lighting & electric components, lighting fixtures.
- windows for transportation vehicles (trains, buses, aircrafts ,ships & boats etc.)
- safety applications such as security force shields, safety glasses, helmet visors.

Polycarbonate Multiwall Sheet

Işık Plastik Policam Polycarbonate Multiwall Sheets have excellent properties with a wide product range as up to 7 wall 16&20 mm and 9 walls 25&32 mm structured panels. By the strengthened structure, these panels offer increased durability and loading capacity with reduced deflection and also their good heat retention values, our Climax series give buildings the best performance in energy efficiency.

Policam Polycarbonate Multiwall Sheet is perfect for applications requiring a material which offers; high light transmission, thermal insulation, lightness of weight with strength, high shock resistance, flame retardation, great economy and design flexibility. Application fields include horticultural purposes such as greenhouse coverings where good thermal insulation is necessary together with high light transmission, constructional purposes for various glazing applications, skylights, walkways, windows, shelters, and insulated roofing, architectural purposes with the ability to be cold-formed into arches , and also can be used for walkways, indoor shopping centers, swimming pool coverings,

skylights, and other enclosures, home improvement purposes for easy do-it-yourself projects like window replacements, shower enclosures, hobby greenhouses, partitions, light covers, patio covers, carports and more

From transport to installation, Policam will maintain its durability. Even when exposed to elevated outdoor temperatures over a long period of time, it will maintain its structural integrity. It resists cracking and splintering during fabrication, assuring you a high degree of safety and it can be cold formed on site.

Extruded as a multiwall sheet it is extremely stronger than glass and is ideal for replacing old roofs. Because of its strength, light weight and pleasing appearance, polycarbonate is ideal for conservatory roofs and is used by most of conservatory manufacturers. With the UV protective layer, it provides great protection from the sunlight while allowing excellent light transmission. Işık Plastik Policam Polycarbonate Multiwall Sheets come with a 10 year limited warranty.

Properties of Işık Plastik Policam Multiwall Polycarbonate Sheets

- Very high impact resistance.
- Excellent light transmission.
- Excellent thermal insulation.
- UV resistant.
- B s1 d0 /Class 1Y / UL 94 HB fire rated.
- Outstanding weatherability.
- Easy to cut & machine
- Can be formable with cold bending.
- Chemical resistant.
- Reduces noise transmission.
- Lightweight.
- Hail resistant.
- Operational temperature -40 °C, +120 °C.
- On site machining.

Possible Applications of Işık Plastik Policam Multiwall Polycarbonate Sheets:

- Conservatories
- Canopies
- Vertical glazing
- Displays
- Covered walkways
- Curved roof lights
- Industrial roof lights
- Signage
- Glazing applications, skylights, walkways, windows, shelters,
- Greenhouse coverings
- Walkways
- Indoor shopping center
- Swimming pool coverings
- Skylights

Policam Multiwall sheets are produced according to EN 16153 light transmitting flat multiwall polycarbonate (PC) sheets for internal and external use in roofs, walls and ceilings-Requirements and test methods. All Policam Multiwall product series have CE Standards.

2. GENERAL HEALTH AND SAFETY PRECAUTIONS

All safety instructions must be followed by qualified operators for all applications of Policam™ Polycarbonate extruded sheets including thermoforming and fabricating processes.

Operators must take into consideration that heat for thermoforming, machining, finishing, annealing etc. of Polycarbonate sheets.

Also, bonding and cementing of Polycarbonate Solid and Multiwall Sheets with solvent and polymerization adhesives introduces other vapors related to the formulation of the adhesives.

But under recommended techniques at recommended temperatures, with adequate ventilation there should be no harmful results may occur.

All fabrication process should be done in well ventilated workplaces, workshops or plants. For ventilating standards please refer to The American Conference of Governmental Industrial Hygienists (ACGIH), Air Contaminant Standards.

All fabrication and forming techniques has special conditions which should be cared. So please follow the further instructions about safety precautions in every section of this manual.

3. STORING AND HANDLING

The originally packed Policam™ Polycarbonate Solid and Multiwall Sheets should be stored under suitable conditions. Sheets must be avoided direct sunlight exposure and also variations of weather and temperature. With wide range variation of temperature and humidity may causes distortion of the flat sheets even when stored flat and stacked.

Policam™ Polycarbonate Solid and Multiwall Sheets comes with polyethylene (PE) film on its surface to keep itself clean and also protect against dirt, dust, mechanical load and scratches. It is highly recommend removing protective PE film just before the final process.

Please follow instructions below regarding storing and handling:

- Policam™ Polycarbonate Solid and Multiwall Sheets should never be stored outdoors.
- Do not store Policam™ Polycarbonate Solid and Multiwall Sheets in direct sunlight.
- Do not be stored near radiators, steam pipes or other heat sources.
- Do not stored near spray painting booths or expose it to other solvent vapors.
- Storage areas should be well ventilated. Air should circulate freely and should be relatively moist and cool.
- Policam™ Polycarbonate Solid Sheet should be stored vertically or in special racks where the sheet can lean at an angle of approximately 10°. These angled racks should have plywood panels, which give full support to the material.

Multiwall polycarbonate sheets must be stored and transported horizontally on a suitable pallet, supported along the entire length and width. If sheets of different length require stacking ensure that the longest lengths are on the bottom to avoid unsupported overhangs. Cover the stored sheets with an opaque plastic film sheet to protect from the wind, rain and direct sunlight. Polycarbonate sheet should be stored indoors whenever possible.

As with all glazing materials multi-wall polycarbonate sheet is considered fragile, therefore care must be taken during transport and handling to prevent scratches and damage to the edges of the sheets. Policam™ Polycarbonate Solid and Multiwall Sheets are individually protected using a protective film and the open ends of the sheet are taped to prevent ingress of contaminants. Do not walk across sheets of polycarbonate.

4. CLEANING

After you remove the protective polyethylene (PE) film from the surface of the sheet, it may induce electrostatic charge. This charge may cause to collect airborne dust or some particles on the surface. It is recommended to remove PE film with antistatic treatment such as blowing by ionized compressed air or cleaning by hand with a cloth wetted with suitable antistatic agents.

To clean Policam™ Polycarbonate Solid and Multiwall Sheets, you should use unaggressive materials and solvents. The UV-resistant surface treatment on one side of the polycarbonate sheet significantly improves long-term weatherability. Periodic cleaning using proper procedures and compatible cleaners are recommended to prolong the service life.

Ideally, there are a number of factors which determine the frequency of the cleaning process and these may include: the geographical location; the surrounding environment such as industrial, marine or alkaline environment; prevailing winds; possibility of airborne debris and the prevailing atmospheric pollution.

4.1. How to Clean Polycarbonate Sheet?

Cleaning a polycarbonate sheet is such a simple process which involves the following simple steps:

Choosing the types of cleaners; you must use only the recommended cleaners. All cleaning agents are tested in laboratories to ensure that they actually compatible with carbonate sheets. Some products which are incompatible with sheets under laboratory conditions include: Lysol, pinesol, butyl cellosolve, isopropanol and formula 409. They should not be used during the cleaning process.

You must not use either your hand or a dry cloth to clean polycarbonate sheets. This is for the reason that; the two will only rub the dirt off the surface of the polycarbonate material as much as it will be rubbing it off. Thus, it will only be a waste of time and energy.

You must blow the dirt off using water and a soft cloth. For larger areas, you can blow off the dirt using a high-pressure water cleaner of about 100bar. As a rule, before you begin cleaning the entire surface, start by cleaning a smaller section of the polycarbonate material. You can use lukewarm water alongside the recommended cleaning agents since it helps to take off stubborn stains without damaging the material.

If there are stains which require scrubbing; you must use a soft cloth to rub the surface. There quite a number of automobile polishes which are used to minimize the chances of scratching the surface of the sheets. Finally, you must rinse the polycarbonate material with clean water to remove all residues of the cleaning agents. Furthermore, it is advisable to dry its surface by using a soft cloth since this will prevent water spotting.

- Rinse polycarbonate sheet with lukewarm water.
- Wash polycarbonate sheet with a mild soap and lukewarm water.
- Use a soft cloth or sponge and gently wash with an up and down motion in the same direction as the flutes.
- Rinse the cloth or sponge and change the water often. Do not scrub or use brushes or squeegees. The coating on polycarbonate sheets is UV-resistant; it is not a mar-resistant coating.
- Repeat rinse and dry with a soft cloth to prevent water spotting.

Pay Attention for these key factors;

- You must not use any abrasive material since this will only leave the surface of the material with a lot of scratches. This is for the reason that; despite the fact that these materials are known for their high impact-resistance, they are not scratch resistant.
- Avoid the use of "harsh" solvents such as hydrochloric acids since they will degrade the surface of the material.
- When you are cleaning polycarbonate sheets; you should not clean them at high temperatures or in direct sunlight. This is can lead to discoloration.
- Polycarbonate sheets are treated on one side for protection against UV damage. This treated side must be glazed outward or toward the light source to provide protection for polycarbonate sheet substrate.

4.2. Cleaning a Polycarbonate Conservatory Roof

Cleaning a conservatory roof is an important care and maintenance procedure. It is only those conservatory roofs which have been maintained that can last for years while still maintaining their appealing look. The available polycarbonate conservatory roofs are associated with low maintenance costs. In situations where the conservatory roof is very high, you can hire a cleaning company which can help you to go about the process. At times, cleaning the high places of the roof may require a professional. They will use specialized tools and equipment which will not cause harm to the roofing panel. The polycarbonate conservatory roofs have increased in the recent past with each and every house hold doing all that it takes to own these important equipment. Cleaning a polycarbonate conservatory roof to keep it sparkling clean will depend on the following key elements:

The cleaning product and the method of cleaning: One main problem that every individual will have to solve is how they'll get to the top of the roof safely. Normally, it is advisable to go for those tools which can enable you to go about the cleaning process while standing on the ground. This is because when you're cleaning the roof while standing on the roof my put you at risk.

The polycarbonate roofing sheets are treated with UV-resistant layer at one or both sides. As much as the polycarbonates are resistant to various chemicals, they can be affected with certain cleaning detergents due to their chemical composition. As a rule, never ignore the cleaning rules. When you use a wrong cleaning detergent, it may affect the coating which may reduce the overall lifespan of the polycarbonate roofing sheet. In addition to this, the polycarbonate sheet will no longer be covered under the warranty.

Avoid scrubbing polycarbonate sheets with stiff brushes .It doesn't matter how stubborn the stain might be – just avoid it. Remember, polycarbonates are susceptible to scratches. Mild warm soapy water is enough. At the same time, you should avoid cleaning these roofing sheets during hot days. When you're cleaning a polycarbonate conservatory roof, try as much as possible not to exert a lot of stress on the sheet. This is because when a polycarbonate roofing sheet is subjected to a lot of stress, it becomes susceptible to most chemicals. These chemicals do interfere with their chemical structure thereby reducing the performance.

5. CHEMICAL RESISTANCE

You can find the chemical resistance table of polycarbonate below. Compatibility notes are;

[1]. Satisfactory to 22°C (72°F)

[2]. Satisfactory to 48°C (120°F)

Chemical Effect Ratings:

A = Excellent. B = Good, Minor Effect, slight corrosion or discoloration. C = Fair, Moderate Effect, not recommended for continuous use. Softening, loss of strength or swelling may occur. D = Severe Effect, not recommended for ANY use.

Chemical	Compatibility	Chemical	Compatibility
Acetaldehyde	C[1]-Fair	Hydrofluoric Acid 75%	D-Severe Effect
Acetamide	D-Severe Effect	Hydrogen Gas	A[2]-Excellent
Acetic Acid	B[1]-Good	Hydrogen Peroxide 10%	A[2]-Excellent
Acetic Acid 20%	A[1]-Excellent	Hydrogen Peroxide 100%	A-Excellent
Acetic Acid 80%	B[1]-Good	Hydrogen Peroxide 30%	A[2]-Excellent
Acetic Acid, Glacial	B[1]-Good	Hydrogen Peroxide 50%	A[2]-Excellent
Acetic Anhydride	D-Severe Effect	Hydrogen Sulfide (aqua)	A-Excellent
Acetone	D-Severe Effect	Isooctane	B[1]-Good
Acetyl Chloride (dry)	D-Severe Effect	Isopropyl Acetate	D-Severe Effect
Acetylene	D-Severe Effect	Isopropyl Ether	D-Severe Effect
Acrylonitrile	D-Severe Effect	Jet Fuel (JP3, JP4, JP5)	A[1]-Excellent
Alcohols: Amyl	B[1]-Good	Kerosene	D-Severe Effect
Alcohols: Butyl	A[2]-Excellent	Ketones	D-Severe Effect
Alcohols: Ethyl	B[2]-Good	Lacquer Thinners	B-Good
Alcohols: Isopropyl	A[2]-Excellent	Lacquers	D-Severe Effect
Alcohols: Methyl	B[1]-Good	Lactic Acid	B-Good
Aluminum Chloride	A[1]-Excellent	Lard	A[1]-Excellent
Aluminum Chloride 20%	A[1]-Excellent	Lead Sulfamate	A[1]-Excellent
Aluminum Hydroxide	B[1]-Good	Lithium Chloride	B[1]-Good
Aluminum Nitrate	A[1]-Excellent	Lithium Hydroxide	D-Severe Effect
Aluminum Potassium Sulfate 10%	A[1]-Excellent	Lubricants	A[1]-Excellent
Aluminum Potassium Sulfate 100%	A[2]-Excellent	Lye: Ca(OH)2 Calcium Hydroxide	D-Severe Effect
Aluminum Sulfate	A-Excellent	Lye: KOH Potassium Hydroxide	D-Severe Effect

Amines	D-Severe Effect	Lye: NaOH Sodium Hydroxide	D-Severe Effect
Ammonia 10%	D-Severe Effect	Magnesium Bisulfate	A[1]-Excellent
Ammonia, anhydrous	D-Severe Effect	Magnesium Carbonate	A[1]-Excellent
Ammonia, liquid	D-Severe Effect	Magnesium Chloride	A[2]-Excellent
Ammonium Chloride	A[2]-Excellent	Magnesium Hydroxide	A[1]-Excellent
Ammonium Hydroxide	D-Severe Effect	Magnesium Nitrate	A[1]-Excellent
Ammonium Oxalate	A[1]-Excellent	Magnesium Sulfate (Epsom Salts)	A[1]-Excellent
Ammonium Phosphate, Dibasic	A[2]-Excellent	Manganese Sulfate	A[1]-Excellent
Ammonium Sulfate	A[2]-Excellent	Mercuric Chloride (dilute)	A-Excellent
Amyl Acetate	D-Severe Effect	Mercurous Nitrate	A[2]-Excellent
Amyl Alcohol	B[1]-Good	Mercury	D-Severe Effect
Aniline	D-Severe Effect	Methanol (Methyl Alcohol)	B[1]-Good
Aniline Hydrochloride	D-Severe Effect	Methyl Acetate	D-Severe Effect
Antimony Trichloride	A[2]-Excellent	Methyl Alcohol 10%	B[1]-Good
Aqua Regia (80% HCl, 20% HNO3)	D-Severe Effect	Methyl Butyl Ketone	D-Severe Effect
Arsenic Acid	A[1]-Excellent	Methyl Cellosolve	D-Severe Effect
Asphalt	D-Severe Effect	Methyl Chloride	D-Severe Effect
Barium Carbonate	A[2]-Excellent	Methyl Ethyl Ketone	D-Severe Effect
Barium Chloride	A-Excellent	Methyl Isobutyl Ketone	D-Severe Effect
Barium Hydroxide	D-Severe Effect	Methyl Isopropyl Ketone	D-Severe Effect
Barium Nitrate	D-Severe Effect	Methylene Chloride	D-Severe Effect
Barium Sulfate	D-Severe Effect	Milk	A-Excellent
Beer	A[2]-Excellent	Mineral Spirits	C-Fair
Benzaldehyde	D-Severe Effect	Monochloroacetic acid	D-Severe Effect
Benzene	D-Severe Effect	Morpholine	D-Severe Effect
Benzene Sulfonic Acid	D-Severe Effect	Motor oil	A-Excellent
Benzoic Acid	B[1]-Good	Mustard	A-Excellent
Benzol	D-Severe Effect	Naphtha	B-Good
Benzonitrile	A[1]-Excellent	Nickel Chloride	A[2]-Excellent
Bromine	C[1]-Fair	Nickel Nitrate	D-Severe Effect
Butadiene	D-Severe Effect	Nickel Sulfate	A-Excellent
Butane	D-Severe Effect	Nitric Acid (20%)	B[1]-Good

Butanol (Butyl Alcohol)	B[1]-Good	Nitric Acid (50%)	B-Good
Buttermilk	A[1]-Excellent	Nitric Acid (5-10%)	A-Excellent
Butyl Amine	D-Severe Effect	Nitric Acid (Concentrated)	C[1]-Fair
Butyl Phthalate	D-Severe Effect	Nitrobenzene	D-Severe Effect
Butylacetate	D-Severe Effect	Nitromethane	D-Severe Effect
Butylene	D-Severe Effect	Oils: Cinnamon	D-Severe Effect
Butyric Acid	D-Severe Effect	Oils: Citric	A-Excellent
Calcium Bisulfate	D-Severe Effect	Oils: Fuel (1, 2, 3, 5A, 5B, 6)	B-Good
Calcium Bisulfite	D-Severe Effect	Oils: Mineral	B-Good
Calcium Carbonate	C2-Fair	Oils: Olive	A[2]-Excellent
Calcium Hydroxide	D-Severe Effect	Oils: Orange	C[1]-Fair
Calcium Hypochlorite	D-Severe Effect	Oils: Pine	A-Excellent
Calcium Nitrate	A[2]-Excellent	Ozone	A[1]-Excellent
Calcium Sulfate	A[2]-Excellent	Paraffin	A[1]-Excellent
Carbolic Acid (Phenol)	D-Severe Effect	Pentane	A-Excellent
Carbon Disulfide	D-Severe Effect	Perchloroethylene	D-Severe Effect
Carbon Tetrachloride	D-Severe Effect	Phenol (10%)	B[1]-Good
Carbonic Acid	A[1]-Excellent	Phenol (Carbolic Acid)	D-Severe Effect
Chlorine, Anhydrous Liquid	C-Fair	Phosphoric Acid (>40%)	A-Excellent
Chloroacetic Acid	D-Severe Effect	Phosphoric Acid (crude)	A-Excellent
Chlorobenzene (Mono)	D-Severe Effect	Phosphoric Acid (S40%)	A-Excellent
Chloroform	D-Severe Effect	Phosphoric Acid Anhydride	D-Severe Effect
Chlorosulfonic Acid	C[1]-Fair	Phosphorus Trichloride	C-Fair
Chocolate Syrup	A-Excellent	Photographic Developer	A[2]-Excellent
Chromic Acid 10%	B-Good	Photographic Solutions	A[1]-Excellent
Chromic Acid 30%	C-Fair	Phthalic Anhydride	A[1]-Excellent
Chromic Acid 5%	B-Good	Picric Acid	D-Severe Effect
Chromic Acid 50%	D-Severe Effect	Potassium Bromide	A[1]-Excellent
Cider	A-Excellent	Potassium Chlorate	A[1]-Excellent
Citric Acid	A[1]-Excellent	Potassium Chloride	A-Excellent
Copper Cyanide	D-Severe Effect	Potassium Dichromate	A[1]-Excellent
Copper Nitrate	D-Severe Effect	Potassium Hydroxide (Caustic Potash)	D-Severe Effect

Copper Sulfate>5%	A[1]-Excellent	Potassium Nitrate	A[1]-Excellent
Copper Sulfate 5%	A[1]-Excellent	Potassium Permanganate	A[2]-Excellent
Cresols	D-Severe Effect	Potassium Sulfate	A[1]-Excellent
Cresylic Acid	D-Severe Effect	Propane (liquefied)	C[1]-Fair
Cupric Acid	A[1]-Excellent	Propylene Glycol	B[1]-Good
Cyclohexane	B-Good	Pyridine	D-Severe Effect
Cyclohexanone	D-Severe Effect	Resorcinal	B[1]-Good
Detergents	A[1]-Excellent	Salicylic Acid	A[1]-Excellent
Diacetone Alcohol	D-Severe Effect	Salt Brine (NaCl saturated)	A-Excellent
Dichlorobenzene	D-Severe Effect	Sea Water	A[2]-Excellent
Dichloroethane	D-Severe Effect	Silicone	A[2]-Excellent
Diesel Fuel	A[2]-Excellent	Silver Nitrate	A[2]-Excellent
Diethyl Ether	D-Severe Effect	Soap Solutions	A[1]-Excellent
Diethylamine	D-Severe Effect	Soda Ash (see Sodium Carbonate)	A-Excellent
Diethylene Glycol	B[1]-Good	Sodium Acetate	A[1]-Excellent
Dimethyl Aniline	D-Severe Effect	Sodium Benzoate	A[2]-Excellent
Dimethyl Formamide	D-Severe Effect	Sodium Bicarbonate	A[2]-Excellent
Epsom Salts (Magnesium Sulfate)	A[1]-Excellent	Sodium Bisulfate	A[1]-Excellent
Ethanol	B[2]-Good	Sodium Bisulfite	A[1]-Excellent
Ethyl Acetate	D-Severe Effect	Sodium Borate (Borax)	A[1]-Excellent
Ethyl Benzoate	D-Severe Effect	Sodium Carbonate	A[2]-Excellent
Ethyl Chloride	D-Severe Effect	Sodium Chlorate	A[1]-Excellent
Ethylene Bromide	D-Severe Effect	Sodium Chloride	A[2]-Excellent
Ethylene Chloride	D-Severe Effect	Sodium Chromate	A[2]-Excellent
Ethylene Chlorohydrin	D-Severe Effect	Sodium Hydroxide (20%)	A[2]-Excellent
Ethylene Diamine	A[2]-Excellent	Sodium Hydroxide (50%)	D-Severe Effect
Ethylene Dichloride	D-Severe Effect	Sodium Hydroxide (80%)	D-Severe Effect
Ethylene Glycol	B[1]-Good	Sodium Hypochlorite (<20%)	C-Fair
Ethylene Oxide	C[1]-Fair	Sodium Peroxide	A[2]-Excellent
Fatty Acids	B[1]-Good	Sodium Sulfate	A[2]-Excellent
Ferric Chloride	A[2]-Excellent	Sodium Sulfide	D-Severe Effect
Ferric Nitrate	A[1]-Excellent	Sodium Thiosulfate (hypo)	D-Severe Effect

Ferric Sulfate	A[1]-Excellent	Stannic Chloride	A[1]-Excellent
Ferrous Chloride	D-Severe Effect	Stearic Acid	A[1]-Excellent
Ferrous Sulfate	A[1]-Excellent	Stoddard Solvent	A[2]-Excellent
Fluorine	C-Fair	Styrene	D-Severe Effect
Fluosilicic Acid	A[1]-Excellent	Sulfur Dioxide (dry)	A[1]-Excellent
Formaldehyde 100%	A[2]-Excellent	Sulfuric Acid (<10%)	A[1]-Excellent
Formaldehyde 40%	A[1]-Excellent	Sulfuric Acid (10-75%)	B[1]-Good
Formic Acid	A[1]-Excellent	Sulfuric Acid (75-100%)	D-Severe Effect
Freon 113	B[1]-Good	Sulfuric Acid (hot concentrated)	D-Severe Effect
Fuel Oils	B[1]-Good	Tannic Acid	C-Fair
Furfural	D-Severe Effect	Tetrachloroethylene	D-Severe Effect
Gasoline (high-aromatic)	A-Excellent	Tetrahydrofuran	D-Severe Effect
Gasoline, leaded, ref.	A[2]-Excellent	Toluene (Toluol)	D-Severe Effect
Gasoline, unleaded	A[2]-Excellent	Tomato Juice	A[1]-Excellent
Glucose	A[1]-Excellent	Trichloroacetic Acid	D-Severe Effect
Glycerin	A[2]-Excellent	Trichloroethane	D-Severe Effect
Heptane	B-Good	Turpentine	D-Severe Effect
Hexane	D-Severe Effect	Urea	D-Severe Effect
Honey	A[1]-Excellent	Vinegar	A[2]-Excellent
Hydrazine	D-Severe Effect	Water, Acid, Mine	B[2]-Good
Hydrochloric Acid 100%	D-Severe Effect	Water, Distilled	A[2]-Excellent
Hydrochloric Acid 20%	B[1]-Good	Water, Fresh	A[2]-Excellent
Hydrochloric Acid 37%	D-Severe Effect	Water, Salt	A[2]-Excellent
Hydrocyanic Acid (Gas 10%)	B[1]-Good	Whiskey & Wines	A[1]-Excellent
Hydrofluoric Acid 100%	D-Severe Effect	Xylene	D-Severe Effect
Hydrofluoric Acid 20%	D-Severe Effect	Zinc Chloride	A[2]-Excellent
Hydrofluoric Acid 50%	D-Severe Effect	Zinc Sulfate	A[2]-Excellent

- ***After this point, we present this manufacturing guide separately for solid and multiwall sheets because of their structure differences. You can find solid section below and multiwall section at further pages.***

6. POLICAM™ POLYCARBONATE SOLID SHEET MANUFACTURING GUIDE

6.1. Introduction

This section of this guide prepared for secondary fabrication operations of Policam™ Polycarbonate Solid Sheets. We would like to give essential information of some processes such as cutting, sawing, drilling, bending, decorating, thermoforming, assembling etc. of flat solid sheets.

6.2. Drying

Depending on storage and climatic conditions, plastic sheets absorb moisture. Like most other plastics, polycarbonate sheets absorb moisture during storage. Although humidity absorption has no practical influence on the physical properties, it may interfere during further processing of the sheets at higher temperatures e.g. during bending, or heating before thermoforming. Before processing at the high temperatures, it is highly recommend pre-drying treatment to avoid bubbles and surface defects.

Sheets should be dried with protective film but in this case, sheets should not touch any place, it will be better if the sheets keep suspended in the oven.

Whilst the amount of water absorbed is not significant compared to other hygroscopic materials, it is essential that it is removed prior to forming. A hot-air circulating oven at 125°C ± 3°C is recommended. To avoid warpage, drying temperatures should not exceed 125°C and the air volume in the oven should be changed six times per hour to allow for the removal of water vapor. After removing the protective masking, the sheets should be hung vertically in the drying oven and pre-dried according to the recommendations.

The maximum cooling speed after drying has to be less than 15°C per hour to avoid repeated induction of moisture or internal stress due to cooling down too fast after drying.

Sheets need not be pre-dried before thermoforming process unless if they keep stored under suitable conditions and protective polyethylene (PE) film is undamaged.

Sheet Thickness (mm)	Sheet Thickness (in)	Drying Time (hrs)
1,00	0,04	1
1,50	0,06	1,5
2,00	0,08	3
3,00	0,12	4
4,00	0,16	10
5,00	0,20	16
6,00	0,24	24
8,00	0,31	36
9,50	0,37	40
12,00	0,47	48

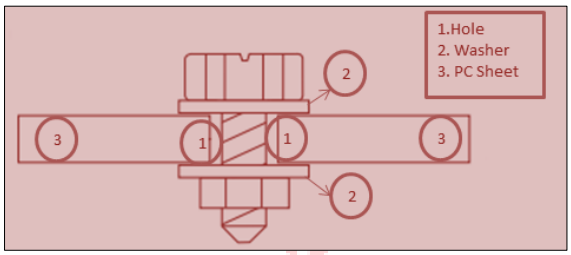
6.3. Bonding and Fastening

Joining of polycarbonate sheets to various materials such as plastic, metal and wood can be achieved through mechanical fastening or bonding with adhesives and solvents.

6.3.1. Mechanical Fastening

You may use some machine screws and aluminum rivets to join polycarbonate sheets to other materials. Application should be done by utilizing proper attachment methods.

Plastic materials dimensions can be change depending on temperatures or internal stress may occur due to environmental conditions so you should drill **oversized holes** and use **washers** to distribute and cushion localized stress. Please take in consideration differentials in expansion factors of materials and make sure that drilled holes are straight and free from cracks.



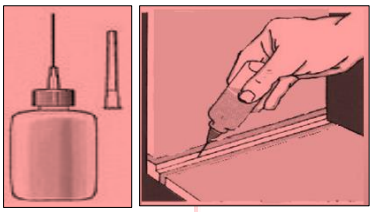
6.3.2. Bonding

The bonding area must be clean before the application. This is best done by rinsing the sheets with lukewarm water. Before washing it in soapy water of the same temperature; use a gentle cloth or sponge and wipe it, preferably in the direction of the grain. It is important that you do not scrub or use anything with a rough surface, as the sheet will blemish. Rinse it one last time and then dry it off with another cloth.

Selecting Suitable Adhesive: Normally a clear, non-yellowing adhesive is preferred that does not alter the appearance of the polycarbonate – keeping its clarity. There are a number of different industrial adhesive options that can be considered

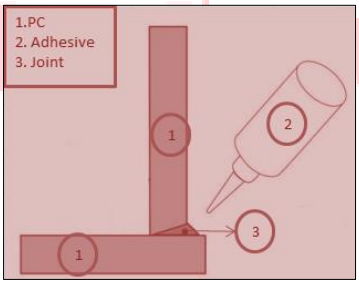
- Cyanoacrylates: These offer a rapid cure and are ideal for small surface areas or for high speed production lines. Opt for an alkoxyethyl cyanoacrylate if surface "frosting" (a white powdery residue) is an issue, also these products tend to smell less pungent. Limitations are a 0.5mm gap fill and environmental exposure – if the joint interface is in contact with water for long periods it can degrade the adhesive. Excess cyanoacrylate adhesive can cause stress cracking of polycarbonate so it is important to minimize excess liquid adhesive or cure it with an activator.
- Two-part epoxy: A strong bond can be formed with a two part epoxy; clear products (in thin film) are available. Thick layers of epoxy may yellow slightly over time. Epoxies offer excellent environmental resistance and are available in a variety of cure speeds to suit the user's requirements. Stress cracking is minimized by thorough mixing in the correct mix ratio so the adhesive cures fully. Faster-set products can also reduce the likelihood of stress cracking.
- Two-part structural acrylics: it is best to opt for a 2 component pre-mix product with a static mixing nozzle to ensure all industrial adhesive is fully reacted to minimize attack on the polycarbonate.
- UV curable adhesives – visible light curing UV-adhesives are an excellent choice for bonding polycarbonate. Due to the UV-stabilization of most polycarbonate, it is important to select a UV which cures in the 400-420µm wavelength spectrum. These products offer a clear, non-yellowing high strength bond and are a favorite for bonding polycarbonate.

Application Procedure: Bonding can be achieved using methods employed in fabricating like acrylic. You can make the application with needle type applicator capillary action and edge dipping. Both methods rely on smooth edge preparation, pressure, and curing. Please take in consideration that solvent bonding reduces the strength of polycarbonate. Small items can be bonded applying solvent along the edges with needle applicators. You should apply the solvent to the entire joint. Large items you can immerse the join surfaces to the solvent until the part is softened. For curing you may clamp the parts in a stable position and wait until the bond is set.



Applicator with needle

You may use polymerization adhesives in some cases. You should chamfering one of the items which will be bond to other one. The adhesive must be mixed as prescribed by the adhesive supplier. The adhesive must be applied bubble-free with a disposable syringe. Excess adhesive must be provided as the polymerization adhesive exhibits volume shrinkage during curing.



Polymerization Adhesive and Chamfering Application

6.3.3. Welding

Hot gas welding, also known as hot air welding is a fabrication process for thermoplastic materials. The process uses a stream of heated gas, usually air, to heat and melt both the thermoplastic substrate material and the thermoplastic welding rod.

Welding rod:

A plastic welding rod, also known as a thermoplastic welding rod, is a rod with circular or triangular cross-section used to bind two pieces of plastic together. They are available in a wide range of colors to match the base material's color. Spooled plastic welding rod is known as "spline".

An important aspect of plastic welding rod design and manufacture is the porosity of the material. A high porosity will lead to air bubbles (known as voids) in the rods, which decrease the quality of the welding. The highest quality of plastic welding rods is therefore those with zero porosity, which are called voidless.

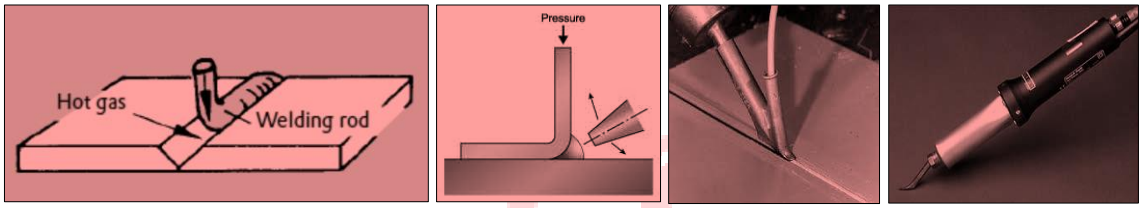
Heat sealing:

Heat sealing is the process of sealing one thermoplastic to another similar thermoplastic using heat and pressure. The direct contact method of heat sealing utilizes a constantly heated die or sealing bar to apply heat to a specific contact area or path to seal or weld the thermoplastics together. Heat sealing is used for many applications, including heat seal connectors, thermally activated adhesives and film or foil sealing.

Freehand Welding:

With freehand welding, the jet of hot air (or inert gas) from the welder is played on the weld area and the tip of the weld rod at the same time. As the rod softens, it is pushed into the joint and fuses to the parts. This process is slower than most others, but it can be used in almost any situation.

Gas-welding temperature should be between 280 - 350°C. Welding pressure with 3 mm rod is about 20 Newton, welding speed should be 200-250 mm/min, try to keep the distance from the welding gun and joint 10 to 20 mm and about 20-25 l/min air will be enough.



Application Figures and Hot Gas Welding Gun

6.3.4. Comparison of Joining Techniques

You can find a comparison table for joining techniques below. "A" stands for "Preferred", "B" stands for "Recommended (conditions permitting)" and C stands for "Not Recommended".

Joint Requirement	*Welding (Thermal)*	*Mechanic*	*Bonding (Chemical)*
High Strength	*A*	*B*	*B*
Leak Proof	*A*	*C*	*A*
Repeat Assembly	*C*	*B*	*C*
Recyclability	*A*	*B*	*B*
Dissimilar Materials	*B*	*A*	*A*
Contamination Free	*A*	*B*	*C*
Chemical Resistance	*A*	*B*	*A*
Fast Cycle Time	*A*	*A*	*C*
Low Capital Cost	*C*	*A*	*B*

6.4. Cutting

You can cut polycarbonate sheets by using workshop equipment. Milling machines with standard high speed tools are useful for cutting. Also, polycarbonate sheet can be cut using industrial cutting lasers. Circular and band saws are the other options for cutting operations.

For a good finish when cutting, all tools must be kept sharp. Most conventional tools are suitable for use with polycarbonate. Power tools can also be used and HSS tool bits are suitable to achieve a good finish. For longer-life, tungsten carbide tipped blades and tool bits would be beneficial while for accurate work where a high degree of finish is required.

6.4.1. Thread Cutting

Standard 4-flute taps can be used for cutting internal threads in plastic sheet. 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.

Definition	Thread Cutting
Cutting Edge	85° (from the center line)
Negative Rake Angle	5°

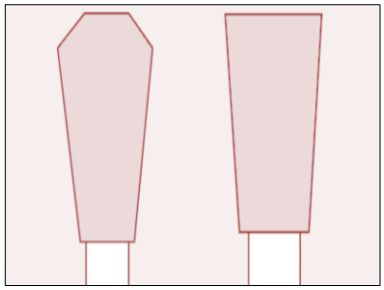
6.4.2. Circular Saw Cutting

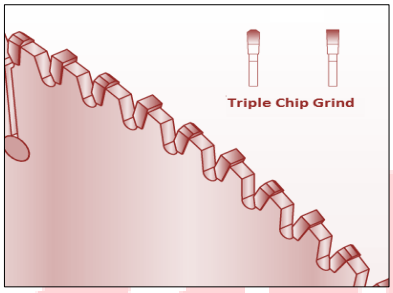
A table saw or overhead panel saw is typically used for cutting polycarbonate sheet. A circular saw blade with carbide teeth, utilizing the "triple chip" tooth design, is the preferred method. Blades for cutting 8 mm and thicker material should have three to five teeth per inch and the hook or rake angle should be 10-degrees to 15-degrees.

When sawing thin gauge polycarbonate, it is important to have a good supporting edge on the saw table with minimal gap between the saw blade and table-supporting edge. Care should be taken to ensure that tabletops are smooth and free from projections that might scratch or mar the sheet.

Circular Blade Specifications	Unit	Value
Thin gauge: 1.5-2.5 mm tooth pitch (1/16" - 3/36")	Teeth per mm (Teeth per inch)	2.5 - 6 (10 - 12)
Heavy gauge: 3.2 - 12 mm tooth pitch (1/8" - 1/2")	Teeth per mm (Teeth per inch)	6.5 - 8.5 (3 - 4)

For best results with polycarbonate sheet, use circular saw blades with the largest diameter possible. The blades should have 60 carbide tipped teeth with a triple-chip tooth design.





Advantages of Triple Chip Grind

- Balanced cutting force
- Best wear resistance
- Good chip flow
- Typically used for cutting metal, aluminum, plastic, and solid surface materials

Triple Chip Grind Figures & Advantages

Triple Chip Grind – TCG is a versatile tooth shape but the primary purpose is for cutting hard materials, like aluminum, laminate flooring, hardwoods and "solid surface". It incorporates flat top raker teeth with what look like a flat top teeth with the corners ground off at an angle. Without using sharp points like ATB (Alternating Top Bevel) or ATAF (Alternating Top Alternating Face) blades, a TCG blade will last much longer and handle the high impact of cutting hard stock. Manufacturers combine this shape with different hook/rake angles to specialize blades, from negative hook angles on non-ferrous blades to very aggressive hooks on rip blades.

6.4.3. Band Saw Cutting

Band saws are useful for trimming formed parts or irregular shapes. Bands saws should be run at 600-1000 m/min and have eight to 12 teeth per inch. Larger blades perform better with thicker gauge polycarbonate sheet. Proper support of the part to be trimmed is important because vibration may induce cracking if the cut is not smooth.

Recommendations	Circular Saw	Band Saw
Clearance Angle	20 - 30°	20 - 30°
Rake Angle	10-15°	0-5°
Cutting Speed	1800-2400 m/min	600-1000 m/min
Feed Speed	19-25 m/min	20-25 m/min
Tooth Spacing	2-5 mm	1,5-2,5 mm

6.4.4. Laser Cutting and Water-Jet Cutting

Laser or water-jet cutting is less common but also possible techniques. Polycarbonate sheets can be laser cut although the cut usually looks burnt and internal stress may result due to the high local temperatures. When laser cutting, it may be necessary to carry out a short annealing cycle at a temperature of 130°C for around 1-2 hours. A laser may be used to make intricate holes and complex patterns, or it can be controlled to merely etch the plastic. Tolerances can be controlled more closely with a laser than with conventional machining operations. Laser power and travel speed must be optimized to minimize 'whitening'. In conclusion if user prefers clear edges, laser cutting is not recommendable.

Water-jet cutting gives a sand blasting look to the edges of sheet. This technique does not create any thermal stress. The cutting speed depends on the sheet thickness.

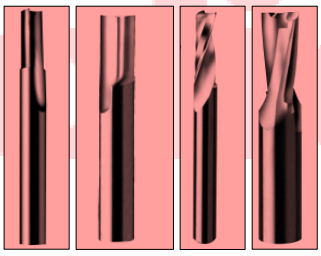
Material Thickness	Water-Jet Cutting Speed
3-5 mm	1500-2000 mm/min
8-12 mm	400-800 mm/min

6.4.5. Routing

Routing Policam™ Polycarbonate Solid Sheets produces a smooth edge. Fixed head, moving head or portable standard woodworking routers are suitable for polycarbonate using the same cutter speeds as for wood. Routing can actually be performed dry but all chips or shavings must be cleared and the cutter kept cool. Compressed air directed onto the cutter and work piece would be preferred.

Cutter	Spindle Speed
6-12mm diameter or less	24000 RPM
>12mm	18000 RPM

About the Tools: O" flute tools, which are distinguished by a half moon design in the face or flute area of the router bit can be used for routing. These single and double edge tools are manufactured from high-speed steel for hand fed applications, and solid carbide for CNC machinery. The high-speed steel material is only available in straight flute configuration, while the solid carbide material utilizes straight and spiral flute geometry. The choice of straight or spiral flute router bits depends greatly on how the user wants to influence the chip. A general rule to follow regarding influencing the chip is to use "O" flute straight or down cut spirals on thermoformed parts where lifting the part can be problematic.



1 2 3 4

1. Single edge "O" flute straight
2. Double edge "O" flute straight
3. Single edge "O" flute spiral
4. Double edge "O" flute spiral

6.5 Milling

Policam™ Polycarbonate Solid sheets can be machined with standard milling cutters fitted with standard high speed knife cutting tools. Clamping for stabilizing is an important matter when machining. You may use jigs, fixtures, or vacuum chucks. But to avoid marks on the sheet you should clamp carefully.

Clearance Angle	**5 - 10°**
Rake Angle	0-10°
Cutting Speed	100-500 m/min
Cutting Feed	0,1-0,5 mm/rev

6.6 Shearing

Die cutting polycarbonate sheet in gauges up to 0.080 inch thick is normally achieved by utilizing the following steps to calculate the required press tonnage:

$$F = (P \times A)/2000$$

Where F= required force in tonnage of the press, P=10,000 psi (shear strength of polycarbonate sheet) and A= the sectional area to be cut.

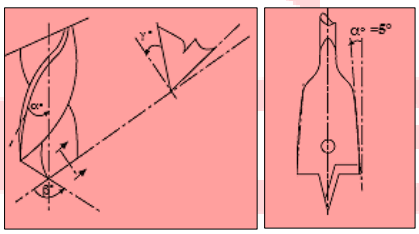
Steel rule dies mounted in a press provide good results. Use 3PT-thick (0.042-inch) steel to fabricate steel rule die-flush, or center bevel ground provides a clean cut. Facet ground steel rule is used to cut thicker gauge sheets, above 0.60 inch. Be sure the platens are parallel and that the backup pad is in good condition. Backup pads can be made from a variety of materials such as nylon, HDPE, etc.

6.7 Drilling

Regarding the drilling issue standard high speed steel twist drills or drills with an angular wedged bit can be used. Carbide-tipped drills useful if they retain their sharp cutting edges.

Regular, new high-speed steel twist drills or new carbide-tipped drills are also suitable. They can be used mainly for bores up to 12 mm diameter. You should use air or water as a coolant if required. Using cutting oils may cause crazing. Be extremely careful if using taps or self-tapping screws; tapping creates notches that can result in stress cracks because polycarbonate is a notch sensitive material.

For larger holes flat, chisel edged drill blades with a triangular cutting tip are suitable. Rake angle should be about 5° to avoid side friction. You can use this kind of drills mainly for bores from 12 to 20mm.



Regular and Chisel Edged Drill Blade

6.7.1. Drilling Operation

Holes should be a minimum of 1.5 x hole diameter from the edge of the sheet. The hole diameter should be a minimum of 6mm larger than the fixing shank diameter for sheets up to 2m and an additional 3mm per meter length thereafter.

- When drilling, hold the work piece firmly or clamp it to the worktable.
- Use air or water as a coolant. Do not use cutting oils.
- Backup the piece being drilled with MDF or plywood to prevent chipping or blowout of the bottom surface. This allows the drill bit to continue into solid material as it penetrates the bottom surface.
- Allow the bit to enter the material using a slow feed rate. Slowing the feed rate as the bit exits the bottom surface prevents chipping.
- As this material is subject to expansion and contraction it is important to allow at least 1-2mm of clearance around the fastener.
- It is important not to allow the thread of the fastener to be hard up against the sheet particularly if the material will be used in an application subject to vibration.

Clearance Angle	5°
Rake Angle	0-5°
Tip Angle	120-160°
Helix Angle	30°

.

Hole Diameter	Speed (rev/min)	Feed (mm/min)
1,5	2000	150
3	1750	125
6	1500	100
9	1000	75
12	650	50

6.8 Annealing

After cutting and fabrication techniques, internal stresses occur. To reduce the possibility of crazing, bending, thermoforming, screen printing, cementing, machining, buffing, flame polishing and other fabrication operations annealing is recommended. The process reduces internal stresses in the sheet which can cause crazing when the polycarbonate comes in contact with solvents such as glass cleaners and some paints. Stress due to water absorption can also cause crazing. Annealing reduces to a minimum the likelihood that crazing or large scale cracking will occur. Annealing can increase bond strength by more than 50%.

You can use commercially available, forced-air circulation ovens designed for the annealing. Good forced air circulation ensures uniform temperatures essential to the annealing process. The oven's air velocity should be between 45-75 meters (150-250 feet) per minute and should be controllable to within +/- 6°C (+/-10°F) to avoid uneven or excessive heating.

If, during the machining process, significant material is removed, annealing is recommended to relieve machined-in-stress and minimize possibility of premature part failure. All extruded stock shape plastics are compressed through a profile die when extruded. The compression that occurs in the material is not relieved because the plastic “sets up” as soon as it comes out of the die and it remains in this compressed or highly stressed state. This high state stress will cause four problems if not addressed:

- Materials will tend to warp and distort
- Material may crack
- Finished part dimension may change. In order to eliminate these problems extruded products are annealed. Annealing is a stress relief process, which occurs when the material is exposed to heat (air or fluid) above its glass transition point, which allows the material to “decompress” back to a relaxed state. Annealing is important if you want a quality, finished part out of your stock shape.

Annealing/Stress Relieving Procedures for Polycarbonate

1. Place parts in air circulating oven such that air can circulate around them.
2. Heat oven to 120°C at a maximum heating rate of 5-10°C per hour.
3. Hold oven temperature at 120°C for 30 minutes plus 15 minutes for every 3 mm of cross-section.
4. Cool oven to 65°C over 10 hours with a maximum cooling rate of 10°C per hour.
5. Turn off oven and allow cooling to room temperature before removing parts.

6.9 Finishing

6.9.1. Vapor Polishing Polycarbonate

Polycarbonate is the most commonly polished transparent plastic. Polycarbonate is readily polished via vapor polishing and is typically the method of choice for most applications. Vapor polishing is a method which utilizes a solvent vapor to flow the surface of the component. The method can produce a polished surface on both exterior and interior features. Machined surface finish quality and cleanliness are important for success.

Benefits of a vapor polish finish include:

- Improves a matte or opaque finish to a high gloss, referred to as optically clear or water clear
- Specified by the medical community to smooth out tool marks where debris in blood pump applications can collect
- Improves manifold applications of polycarbonate or acrylic by enabling viewing of the inside of the manifold for liquid presence
- Also necessary for components that need to pass light unobstructed, such as light emitting diodes in component cavities
- Cosmetic reasons to give the finished part a glossy professional look.

6.9.2. Solvent Polishing Polycarbonate

For having a smoother and glossy edges user may use Butanone, also known as methyl ethyl ketone (MEK) or methylene dichloride. To prevent humidity blush after drying, it may be necessary to add a small amount of a slow-drying component such as diacetone alcohol and glacial acetic acid

6.9.3. Flame Polishing Polycarbonate

Flame Polishing utilizes a hot flame to flow a surface. Flame polishing polycarbonate is not normally an acceptable practice. The sheet will bubble and will be ruined if you apply flame polishing to polycarbonate sheets.

6.9.4. Sanding and Buffing

Sanding can be applied to Policam™ Polycarbonate Solid Sheets. You can have a smooth finish with wet sanding application. Gumming can result from dry sanding. Dry and Wet Sanding requires further finishing to restore gloss. Polishing polycarbonate is conceptually the same as sanding a surface smooth. The only difference is, you have a perfectly see-through surface if you do it right. Whereas sanding goes from course to fine grits, polishing goes from fine, to finer to ultra-fine. If you have more than surface scratches, you may have to gently sand the scratches out, beginning with 400-grit sandpaper and working your way to 1,000-grit or finer. After sanding, switch to a buffing wheel. Use slow speeds. Excess buffing wheel speed, even with very fine rouge, can quickly create enough friction and heat to melt or deform polycarbonate. When in doubt, go slower and lighter. Polycarbonate Sheet can also be buffed using a 2-wheel system. The first wheel uses a buffing compound to remove shallow scratches. The second

buffing wheel is used for restoring the gloss. A belt sander, equipped with a 400-500 grit belt, running at 20 - 30 m/sec, is the preferred option, applying low contact pressure during operation. Wet sanding and waterproof belts are preferable, as they prevent heat buildup, sanding dust accumulation, and prolong sanding belt life. An orbital sander can also be used, but it can be applied only by the dry sanding method. Manual Sanding can also be used, wet or dry, working with successive grit size abrasive paper (Starting with 100, then 280-grit silicon-carbide, and finally 400-600 grit sandpaper).

6.9.5. Edge Finishing With Jointer-Planer

You may use standard jointer planer for polycarbonate edge finishing application. Use carbide or HSS tools. Trying to remove too much material results in a rough edge or cracking of the sheet. Trying to remove too much material results in a rough edge or cracking of the sheet. If you want to get smooth edges, wet sanding with fine grit sandpaper is a good solution.

6.9.6. Edge Polishing

A diamond edge polisher will do a fine job on polycarbonate. Often, one pass of the material over diamond tooling will give you the quality edge your customers require. For that "perfect edge", a light buffing as a secondary operation will be necessary.

6.10 Painting

Whenever you want to paint Policam™ Polycarbonate Solid Sheets please keep in mind that none, one or both sides of the sheet could have an UV cap layer depending on the order for protection direct sunlight. Some painting applications are available for Polycarbonate Sheets. In selecting the paint for painting polycarbonate sheet, follow our recommendations. Avoid using paints containing toluene, xylene chlorinated and aromatic solvents that will craze Polycarbonate Sheets. In thinning the painting, use the suitable solvents. Because solvents can craze or craze polycarbonate, use milder thinners. Many painters use a mixture of 50% water and 50% isopropyl alcohol to clean the surface of the sheet. Be sure to dry thoroughly prior to painting. Use a soft nonabrasive cloth or sponge to avoid scratching .Generally, paint systems based on aliphatic hydrocarbons, such as mineral spirits, alcohols, heptane and hexane, are compatible with polycarbonates.

Recommendations:

- Clean the polycarbonate sheet with a water-based soap, using a nylon sponge.
- Remove static load with ionized air treatment
- Use dry air in compressed air lines
- Avoid too high a delivery rate and too heavy a wet coat thickness.
- Allow adequate drying before applying spray mask to painted areas.
- Do not expose painted faces to a low temperature and high humidity environment during drying.
- Follow curing instructions of paint supplier

6.11 Screen Printing

For high-volume jobs, screen printing is an economical solution. In selecting an ink system, ask your screen print supply distributor for a recommendation. The technical bulletin will give you printing recommendations. The type of mesh, squeegee, stencil and thinners are a few of the variables that will determine the amount of ink deposited on the sheet, which affect the appearance of the sign, when it is illuminated.

Polycarbonate has a naturally high dyne level, which means that you can achieve better ink adhesion. Polycarbonate does not require any surface pretreatment before printing. And, since polycarbonate withstands higher curing temperatures and the stability allows the printer to maintain better registration.

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.

Recommendations:

- Do not add solvents such as toluene, xylene, cellulose acetate, methyl-ethyl-ketones or other related chemicals to the inks.
- Use water-moistened chamois or soft cloths to avoid abrasion or scratching during cleaning prior to printing.
- In order to avoid stress cracking, 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.

6.12 Forming

Policam™ Polycarbonate Solid Sheets can be formed with several forming methods such as Cold and Hot Bending, Thermoforming, Drape Forming Vacuum Forming. You can find essentials of these methods below.

6.12.1. Cold Bending

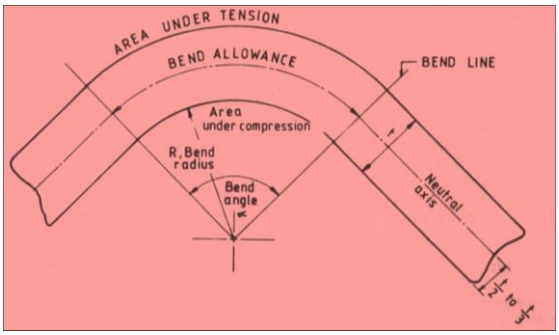
It should be considered that there are some factors when you are bending polycarbonate sheets. To bend a polycarbonate sheet, you need to know the thickness of the sheet and the required radius. The minimum radius which can be realized will depend on the thickness of the polycarbonate material.

During the bending process, the section to be bent is subjected to a given amount of force. In situations where the material cannot withstand these forces, it will break or develop some cracks.

The outer surface will be subjected to a stretching force which will depend on the stiffness of the material, bent radius and thickness of the material. Normally, for polycarbonate sheets, high stress is any value which is above 1500psi.

In this process, the bending radius will be determined by the thickness of the polycarbonate sheet. For instance, a PC sheet with a thickness of about 3 mm can have a minimum bending radius of about 300mm. The basic criteria for the minimum radii is 100 times sheet thickness.

Sheet Thickness (mm)	Min. Bending Radius
1,5	150
2	200
3	300
4	400
5	500
6	600
8	800



6.12.2. Hot Line Bending

Polycarbonate Solid Sheets 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. Hot line bending requires that the polycarbonate sheets are softened along a narrow line by a strip heater. When the optimum sheet temperature is reached (slightly over 160°C and max 167°C) and a slight resistance to bending is noticeable, the part can be readily formed. Trials should be performed on small samples to determine the appropriate value before proceeding to full production. For sheets thicker than 3mm, double sided heating is recommended. Hot line bending can be performed with the film on the sheet except when working on a thickness of 6mm or more. For thicker sheets the heating time and temperature on the surface of the sheet will be too high causing the film to melt locally. However, it is possible to remove the film along the bend line before forming so that most of the sheet remains protected. Stress generated by local line bending can lead to stress-cracking or crazing especially if the sheet is then bonded or decorated. However, stress can usually be reduced, else eliminated by the process of annealing.

Metal contact heaters may not be suitable for use with polycarbonate as they may stick to the surface of the sheet and cause marks.

Trouble Shooting for Line Bending

Problem	Cause	Solution
Bubbling or Blistering	Overheating	Lower Heat Reverse or turn over work. Increase sheet-heater distance
	Wet Material	Apply pre-drying
Wrinkling	Narrow heating	Widen heated area Increase bend radius (bend radius at least twice sheet thickness)
	Bending part the wrong way	Bend away from heated side
Mark off (stray marks on sheet surface)	Surface contact	Avoid overheating Cover jig with felt Reduce areas of contact in cooling jig
Bow effect	Stresses from heated and unheated areas	Use straight nichrome wire to decrease width of heated area Design reverse curve in cooling jig Heat entire part in oven Use a v-groove bend line
	Inherent shrinkage in sheet	Bend sheet perpendicular to direction of manufacture -see foregoing drawing

6.12.3. Thermoforming

Thermoforming is one of the oldest and most common methods of processing plastic materials. Thermoformed plastic products are all around us and play a major part in our daily lives. Forming, Thermoforming, and Heat Forming are universal terms for a variety of thermoplastic sheet-forming techniques. All of these forming methods require a pre-manufactured thermoplastic sheet. The process involves heating the plastic sheet to its forming temperature before stretching the softened sheet against a mold. When the sheet has cooled to the point where it retains the shape of the mold, the sheet is removed and the forming procedure is complete.

There are different thermoforming techniques that can be used to form polycarbonate sheets, once heated, into the shape of a mould by mechanical, air pressure, or vacuum forces. Both male (plug) and female (cavity) moulds are used. To thermoform polycarbonate correctly it must be heated uniformly. Optimum heating times and temperatures will depend upon a number of factors, including thickness of the sheet, the type of mould being used and the degree of stretching required but forming should always be done when the temperature is above the glass transition temperature (Tg) which is approximately 150°C.The required temperature for thermoplastic forming of polycarbonate sheets generally between 180° and 210°C.

Pre-Drying:

Before thermoforming, the polycarbonate sheet must be pre-dried at 125°C ± 3°C. The duration of pre-drying will be dependent about the amount of humidity absorbed by the sheet and by its thickness. Please check the Drying section in this guide for details and explanations.

Sheet Thickness (mm)	Drying Time (hrs)
1,50	1,5
2,00	3
3,00	4
4,00	10
5,00	16
6,00	24
8,00	36
9,50	40
12,00	48
15,00	56

The minimum drying time depends not only on the sheet thickness, but mainly on the moist content. A simple test can be done to obtain optimum drying time: place a part of the dried sheet into an oven at 180°C for 10 minutes. If bubbles appear, the sheet is not fully dried, and process needs to be maintained. As soon as no bubbles appear no more, optimum drying time is set.

About the protective film, you may keep the film on sheet but please keep in mind that printed protective films can cause shading on the surface. The protective film should never touch any heat applicators in the oven.

Heating:

As a general rule, a pre-dried polycarbonate sheet can be safely heated up to 180°–190°C and at this temperature behaves in a manner that enables it be formed into complex shapes with tight curves and deep draw. The entire area of the sheet should be uniformly heated with an air circulating oven with accurate temperature control preferred. As an alternative to air oven heating, certain infra-red heaters can be used such as those with quartz or ceramic

elements. Infrared metal sheathed, coiled nichrome or ceramic heating elements provide the best heating sources. Key features of forming & heating equipment are timer control accuracy, uniform heating sources, and sufficient vacuum power. Single side heating may enough for the sheets up to 4 mm thickness. Dual-side heating is recommended for the sheets thicker than 4 mm.

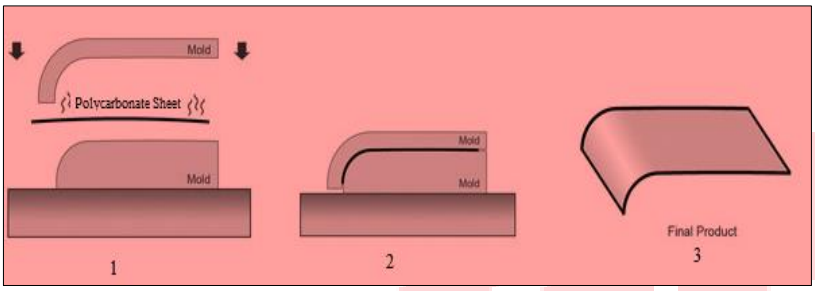
6.12.4. Thermoforming-Drape Forming

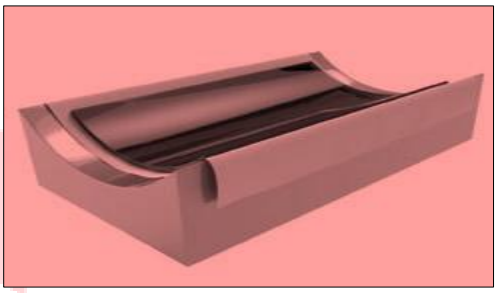
Drape forming is a technique using a single positive mold, on which a heated sheet of plastic is placed. After the sheet is softened by thermal processing, it sags and conforms to the shape of the mold under its own weight or by slight pressure applied by an operator. Drape forming polycarbonate sheets provides an optically clear part with no tooling mark off. By drape forming you can provide beautiful non-flat components, shields, and panels that are crystal clear. The drape forming process has different combinations such as:

- Giving shape under own weight at a temperature of approx. 155°C.
- Giving shape under own weight with a slight mechanical pressure. (Temp. 155°C)
- Cold curving into a jig and placing in an oven at temperatures between 150°C-165°C.
- Cold curving the sheet over a mould, exposure to a temperature of ±150°C and application of vacuum to obtain a 3D shape.

Steps of giving shape under own weight with a slight mechanical pressure:

1. The sheet is heated in an oven until it begins to fold upon itself.
2. Fabric-lined molds hold the malleable plastic to cool.
3. The part takes its general shape without a scratch. Bosses, holes, and other features may now be added to complete the part.





Drape Forming Features

- Optical Clarity or Color
- Limitless Shaping
- High Aesthetics
- Perfect Finishing
- Post Machining & Hardware Options
- Cost Effective

Applications for Drape Forming

- Medical
- Consumer
- Defense
- Electronics
- Display
- Recreational

6.12.5. Thermoforming-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. Because of the good flow properties, polycarbonate, allow you to make complex finished parts. Higher draw ratios can be achieved with Vacuum Forming.

Polycarbonate draw ratio can be up to 3:1

Polycarbonate is ideally suited to the vacuum forming process as it has high extensibility and therefore, high definition within the mould. It is preferable to use automatic machines that grip the sheet from all sides during the entire process. Vacuum forming with pre-drying may be carried out using shallow moulds and in this case the sheet temperature should not exceed 160°C. Uneven heating, resulting in local heating above 160°-165°C may cause bubbles to appear in the overheated area.

In vacuum forming, heated plastic sheet is drawn down onto a male or female tool that has vent holes around the periphery and in areas requiring crisp detail. The application of a vacuum offers improved feature definition and greater wall thickness consistency. Vacuum forming also allows the use of thicker sheet stock and reduces forming time, when compared to drape forming.

There are a few considerations when choosing vacuum forming. The process does not support variable wall thicknesses, and the part's geometry must allow a straight pull (no undercuts or side action). Additionally, vacuum forming cannot manufacture strengthening ribs or mounting bosses that are common in injection molded parts. The final consideration—when using forming equipment designed for prototyping,—is that the side of the part that does not contact the tool surface will lack detail and definition

For large production runs, vacuum forming tools are machined from aluminum. However, the low pressure and temperature of the forming operation facilitates the use of tooling constructed from many materials, including ABS, polycarbonate (PC) and polyphenolsulfone (PPSF/PPSU). Although tool life will not equal that from an aluminum tool, these three materials are ideal for prototyping and short-run manufacturing.

Vacuum forming is a more complex version of 'thermoforming' in that vacuum forming applies this vacuum once the tool penetrates the plastic sheet whereas strictly speaking thermoforming doesn't necessarily require a vacuum to achieve the part. However the terms vacuum forming and thermoforming are often used interchangeably.

Advantages of Vacuum Forming:

Vacuum forming is a beautiful way of creating plastic components. The greatest advantage of vacuum forming over other plastic moulding processes is the cheap tooling costs. Using timber patterns or epoxy resin tools, tooling can be created very quickly and cheaply as tools often don't require CNC programming or complex aluminum tools. For small volume runs where you are unsure about your product commitments vacuum forming is a great way to get your product out there with low initial capital. When producing large components, this saving on tooling cost can be substantial.

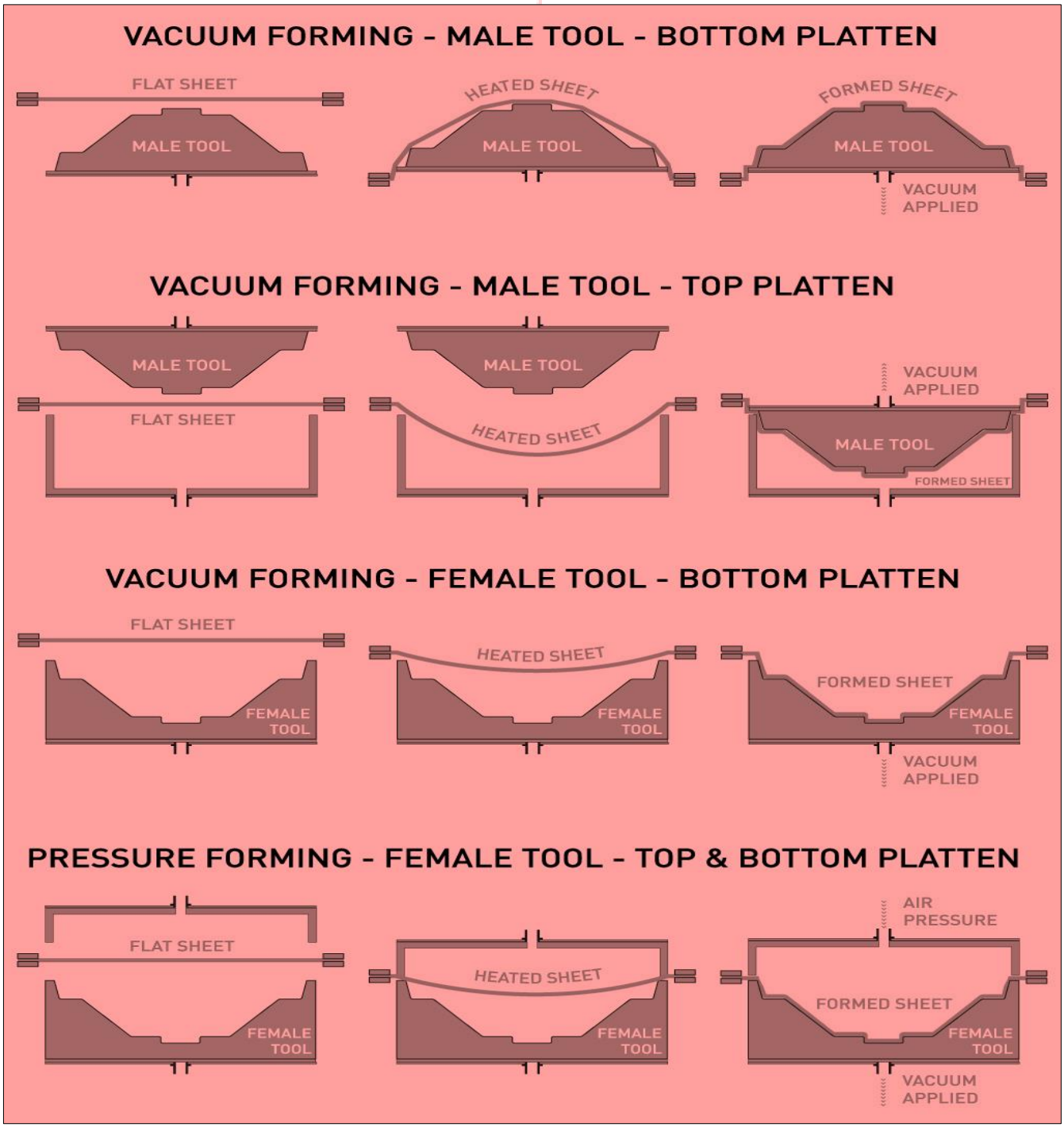
However vacuum forming is absolutely a high volume process as well as we can utilize aluminum tooling and multi-cavity tools than can produce many thousands of parts.

Another unique advantage of vacuum forming is the ability to create pre-printed components.

Molds:

For long production runs when optical quality is required, use temperature controlled aluminum or steel tools. For prototypes or limited production work, tools made of plaster, hardwood, reinforced epoxy or polyester resins may be used. Be aware that the mould material affects both cooling time and finish of the formed parts. It is also preferred that the mould roughness (Ra value) is situated between 1.0 to 1.4. Allow for moulding shrinkage of 0.8 to 1% for polycarbonate. For good evacuation of air, it is important to make an optimum number of holes in the right locations. If that is not the case, optical defects like little pores or craters could be formed. This may occur especially on parts

with large flat surfaces. To avoid venting marks on the final moulding, these vent holes should not have diameters larger than 0.5 - 0.8 mm. Back drilling with larger drills is suggested to speed up air evacuation. A good release of the moulding can be obtained by providing a draft angle of minimum 4 to 6°.



Mold-Process Types illustration

6.12.6. Cooling

After thermoforming, the mouldings can be removed from the mould with little risk of deformation as soon as they have cooled down to about 15-25°C below the T_g value of 150°C. Forced cooling air or water cooling is not recommended.

Cooling times are dependent upon a number of factors. These include ambient, forming and mould temperatures, mould material, cooling system, part thickness and design geometry. Let the part stiffen sufficiently and take it from the mould. Sheet which are formed at higher temperatures cool more rapidly, and because of this it requires more rapid forming. At the same time, however, its high heat deflection temperature under load enables short cooling cycles to be achieved. Using positive moulds, mould shrinkage might cause removal problems. Take care to remove before the part shrinks on the mould. Do not cool too fast, because the generated stresses may result in cracking. If necessary, annealing can be done. Mould shrinkage for Polycarbonate is between 0,8-1,0%

6.12.7 Troubleshooting

Problem	Cause	Solution
Blisters/Bubbles	Overheating/Sheet heated too rapidly	Lower the heater temperatures or reduce the top heater if using twin heating.
	Excessive moisture	Pre – dry sheet. Pre – heat sheet. Heat from both sides. Keep material wrapped until ready to use.
	Uneven Heating	Check consumption. Increase zone control
Poor Mould Release	Mould or part too hot	Increase cooling cycle. Decrease mould temp.
	Mould undercuts	Increase release time and pressure.
	Insufficient draft angles	Increase draft. Convert mould to female.
	Poor Mould Surface	Use mould release. Improve mould surface.
Uneven shapes	Uneven heating temperatures	Be sure all heaters are functioning Eliminate drafts Baffle heat on all sides
	Clamping frame not hot	Preheat clamping frame Preheat entire sheet
Sheet Scorching	Top/Bottom surface too hot	Decrease heating cycle time. Decrease heater temp. Check for faulty heat zones if problem in isolated area. Pre – heat material.
Webbing	Material too hot	Shorten cycle time. Lower heater temperature.
	Insufficient vacuum	Check system for leaks. Increase size of vacuum holes. Check for blocked holes.
	Incorrect Pre-stretch height	Adjust pre-stretch flow and time.
	Excess material	Reduce material size and use reducing windows.
	Poor mould design	Increase radii and improve draw ratios. Use plug/ ring assist. Use assist blocks to pull out webbing. Increase spacing between moulds.

		Switch to female mould.
	Vacuum speed too fast	Regulate to suit. Use smaller vacuum holes.
Poor Detail, Incomplete Forming	Sheet too cold, Clamping frame not hot enough	Heat sheet longer Raise heater temperature If problem occurs in same area every time, check if all heaters are functioning Heat frame to recommended temperature
	Insufficient vacuum or pressure	Check if vacuum/pressure at mold is sufficient Remove 90° bends from vacuum system Check vacuum holes for clogging Increase number of vacuum holes
	Vacuum draw not fast enough	Check vacuum system design Back relieve vacuum holes Use vacuum slots instead of holes
Too much sag	Sheet is too hot	Reduce heating time Reduce heater temperature
Tearing sheet when forming	Sheet is too hot	Reduce heating time Reduce heater temperature
	Sheet is too cold	Increase heating time Increase heater temperature
	Closing speed between mold and sheet too high	Reduce closing speed
Part Warpage	Uneven part cooling	Add more water channels to mold Check for plugged water flow
	Mold temperature too low	Raise part temperature
Surface markings	Mold surface too rough	Use proper mold covering (foam, felt, flocking) Change mold material
	Mold surface too smooth	Grit blast mold surface
	Poor vacuum	Check vacuum system Add vacuum holes
	Mold is too hot	Reduce mold temperature
	Mold is too cold	Increase mold temperature
	Dirt on sheet or mold	Clean with deionizer air
Uneven edges	Excessive forming temperature differential	Preheat clamping frame Use slip clamp frame (low/high)
Raised corners	Excessive stress	Heat frames to proper temperature before inserting sheet Add supplemental heat to corners
Cracking in corners	Stress concentration	Heat sheet evenly Preheat frames or use heated frames Add supplemental heat to corne
Plastic pulls from clamp frame	Insufficient clamp pressure	Check clamp pressure. Adjust alignment. Heat frame prior to inserting sheet.
	Material too cold	Increase heat cycle
	Wrong material selection	Consult supplier

6.13 Installation

Policam™ Polycarbonate Solid Sheets are suitable for some glazing applications and also to save a significant amount of energy at winter and summer seasons. When this kind of applications comes to subject, there are two chief points to keep in consideration especially for outdoor conditions. First one is thermal expansion of Polycarbonate material and the second one is installing correct side of the sheets. As mentioned below Policam™ Polycarbonate Solid Sheets can be produced with one or both side UV protective layer. For outdoor applications, sheets have to mounted as UV layer on outside. You may follow the instructions on printed protective film to choose correct side. Please note that the α coefficient of thermal expansion of Polycarbonate is about 0,065 mm/m°C.

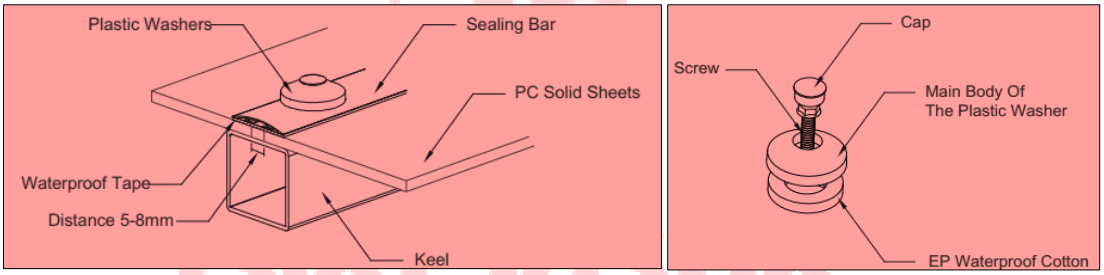
6.13.1. Installation Guide

- According to thermal expansion of Polycarbonate you should reserve some space between two pieces of sheets. The distance should be 5 to 8 mm practically for 1 meter sheet. But you can make a calculation for certain space need.

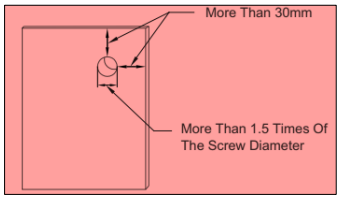
For example: Let's assume the temperature range is between 0°C - 45°C for the installation area of application and you are using one square meter sheet in 5mm thickness. You can calculate as Length*Temperature difference* α (coefficient of thermal expansion of Polycarbonate)

1*0,065*45=2,9 mm expansion.

It is recommended to use plastic washers between two sheets to fix them. Using plastic washers can not only meet the thermal expansion and contraction of the sheets, but also avoid the risk of water leakage.

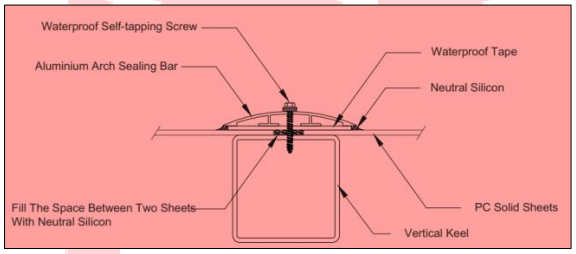


- The hole diameter should be 1,5 times larger than the screw diameter. Also please note that the minimum distance between the external diameter and the side of the sheet should be 30mm

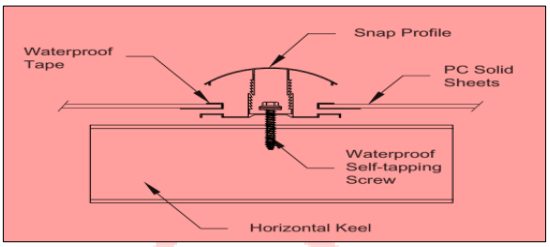


- Remove all protective films after installation. Otherwise film may adhere to the surface of the sheet and hard to be tore off. Avoid strong acids and alkalis. Spread neutral silicon on both sides of the sheet and put the edges into U-profiles which have been pouring into with neutral silicon. The top edge of the U-profile should be sealed with neutral silicon.

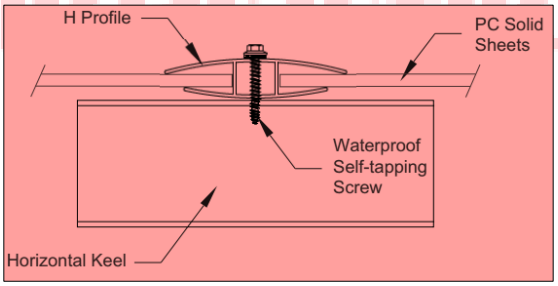
- Installation with Vertical Keel: You should use neutral silicone to fill the gap between the sheets. Also after the installation the edges of the arch sealing bar should be sealing with neutral silicon.



- Other installation methods with Snap Profile and H Profile
  - Snap Profile: Paste the waterproof tape tightly on both edges of the sheet and then put the sheets on the below part of the snap profile. The edges of the top part should be sealed with neutral silicon.

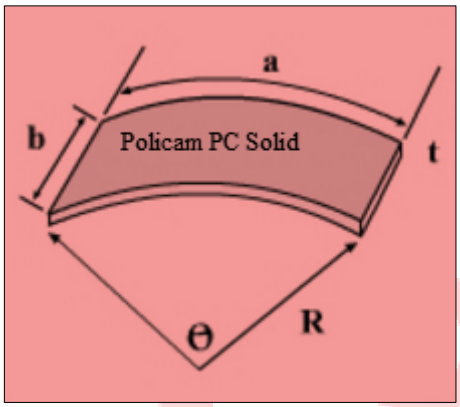


  - H Profile: Spread neutral silicon on both sides of the sheet and put the edges into H-profiles which have been pour into with neutral silicon. The top edge of the H-profile should be sealed with neutral silicon.



6.13.2. Curved Glazing and Barrel Vaults

In some curved glazing applications you can use Policam™ Polycarbonate Solid Sheets depending upon cold bending basics which are also mentioned above in the forming section of this guide. These types of skylights work well to open up hallways and corridors. They offer vaulted transparent or translucent space above and a range of arched rafters from low vaults to hemispherical skylights with glazed vertical ends. They cover building-connecting walkways and can attach to vertical walls at either or both ends. Vault radius is generally determined by other architectural conditions or aesthetic requirements.



a=Length, b=width, t=thickness, Ø =bending angle, R=Radius

The ratio between length and width of the sheet a/b >= 2

The bending angle should be less than 90° Ø < 90°

The bending Radius R >= 150t

7. POLICAM™ POLYCARBONATE MULTIWALL SHEET FABRICATION & INSTALLATION GUIDE

7.1. Introduction

In this section of the guide you can find fabrication and installation basics of polycarbonate multiwall products of Işık Plastik. The basic explanations of fabricating polycarbonate have given on previous sections in this guide. After this point you may find some "specific" instructions which are special for multiwall sheets.

Işık Plastik Policam™ Polycarbonate Multiwall Sheets have excellent properties with a wide product range as up to 7 wall 16&20 mm and 9 walls 25&32 mm structured panels. By the strengthened structure, these panels offer increased durability and loading capacity with reduced deflection and also their good heat retention values, our Climax series give buildings the best performance in energy efficiency.

Policam™ Polycarbonate Multiwall Sheet is perfect for applications requiring a material which offers; high light transmission, thermal insulation, lightness of weight with strength, high shock resistance, flame retardation, great economy and design flexibility. Application fields include horticultural purposes such as greenhouse coverings where good thermal insulation is necessary together with high light transmission, constructional purposes for various glazing applications, skylights, walkways, windows, shelters, and insulated roofing, architectural purposes with the ability to be cold-formed into arches , and also can be used for walkways, indoor shopping centers, swimming pool coverings, skylights, and other enclosures, home improvement purposes for easy do-it-yourself projects like window replacements, shower enclosures, hobby greenhouses, partitions, light covers, patio covers, carports and more

From transport to installation, Policam will maintain its durability. Even when exposed to elevated outdoor temperatures over a long period of time, it will maintain its structural integrity. It resists cracking and splintering during fabrication, assuring you a high degree of safety and it can be cold formed on site.

Extruded as a multiwall sheet it is extremely stronger than glass and is ideal for replacing old roofs. Because of its strength, light weight and pleasing appearance, polycarbonate is ideal for conservatory roofs. With the UV protective layer, it provides great protection from the sunlight while allowing excellent light transmission. Policam™ Polycarbonate Multiwall Sheets come with a 10 year limited warranty.

Applications	
Conservatories	Signage
Canopies	Glazing applications, skylights, walkways, windows, shelters
Vertical glazing	Greenhouse coverings
Displays	Walkways
Covered walkways	Indoor shopping center
Curved roof lights	Swimming pool coverings
Industrial roof lights	Skylights

7.1. Storing and Handling

General storage and handling instructions stated in Storing and Handling section on previous pages. Here you can find some specific points for multiwall polycarbonate sheets.

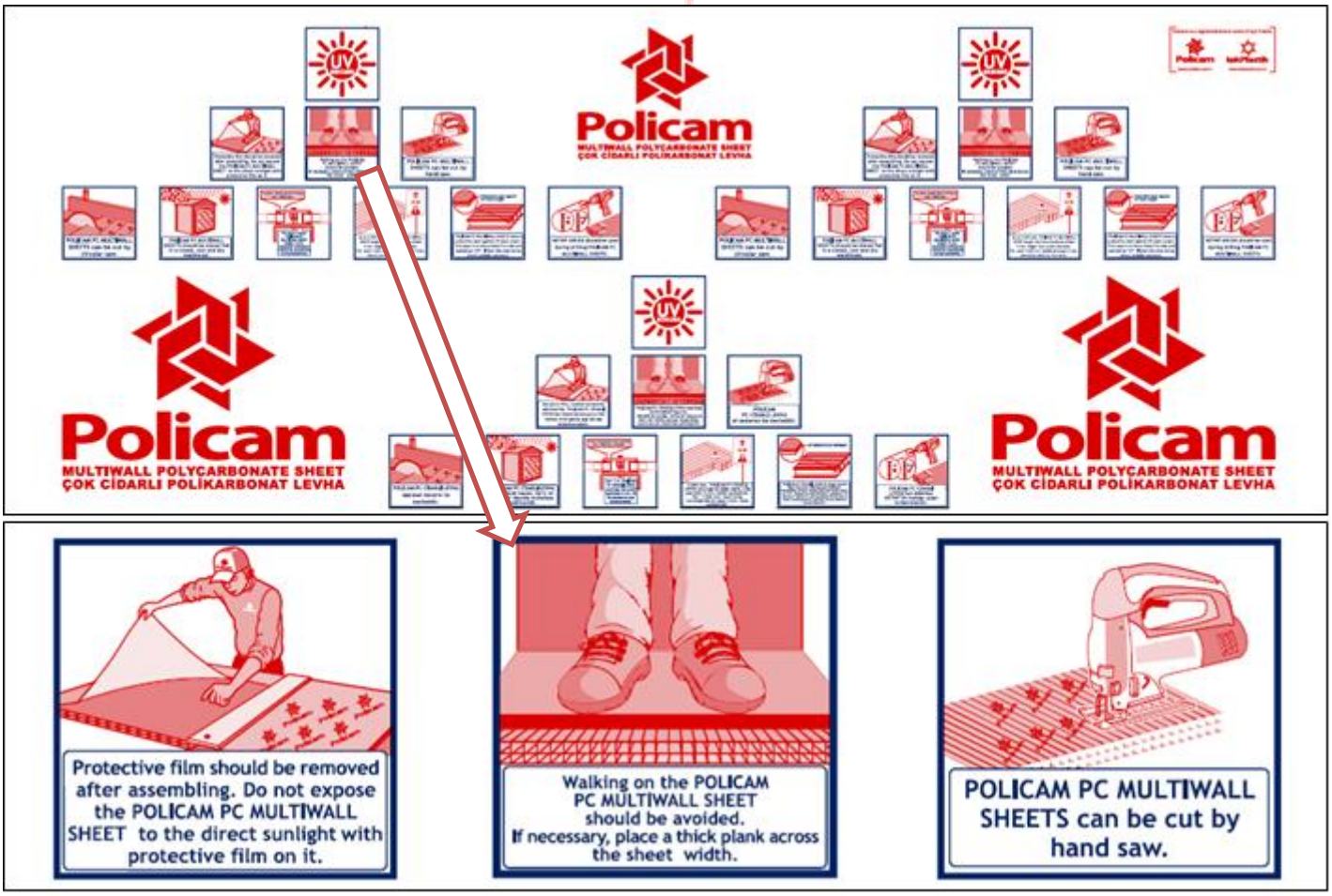
The main issue is to protect sheets from adverse effects of atmosphere with utmost care. Direct sunlight, extreme humidity and rain are the most important influencers on polycarbonate sheets.

Same length sheets should be stored horizontally. If you want to store sheets with different length, the longest sheet should stay at the bottom of the stack to avoid unsupported overhangs.

Policam™ Polycarbonate Multiwall Sheet comes with printed protective film on its surfaces. Protective film should be removed after installation or assembling. Please do not expose the Policam™ Polycarbonate Multiwall Sheet to the direct sunlight with protective film on it.

Necessary care must be taken during transport and handling to prevent scratches and damage to the edges of polycarbonate multiwall sheets.

You can find basic instructions of storing, handling and fabricating multiwall polycarbonate sheets on printed protective film.



Printed Protective Film

7.2. Cutting

Cutting and drilling are both common fabricating processes for polycarbonate multiwall sheets. For cutting operations there are some tools options. The choice of cutting tool mainly depends on the thickness of the sheet and size. You may use sharp tools with fine cutting teeth should be used to minimize vibration and chatter. Sheets should be properly supported along the trim line before cutting.

For 4 mm, 6 mm, 8 mm and 10 mm polycarbonate sheets; you can use circular saw, table saw and saber saw (Finish blade for circular saw / table saw, and a metal cutting blade for a saber saw) for cutting operation.

Circular and Saber Saws Operations:

For circular saw operations you can use a fine-tooth, hollow ground panel blade with 10-12 teeth per inch (12TPI). Clamp a straight-edge to the polycarbonate sheet to guide the saw. To set the proper cutting speed it is recommended to make a test before starting operations. If you cut too slow, material will melt and if you cut too fast you may have large chips. Saber saws equipped with a fine-tooth blade can also be used, but proper support is recommended.

- ✓ It is not recommended to use **utility knifes** for big amount of sheets but you can use some small applications. Always draw the knife away from the hand holding the polycarbonate sheet. Draw the knife lightly to start the cut then repeat with more pressure. When the cut is almost complete, you can flex and snap the pieces to finish the separation.

Table Saw Operations:

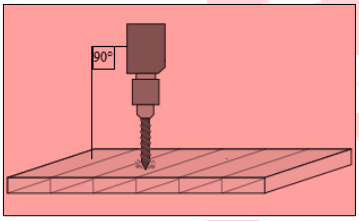
- ✓ Measure and mark desired cut. Frame mark with strips of duct-tape.
- ✓ Mount fine toothed saw blade.
- ✓ Push the sheet into saw at a firm but steady pace.
- ✓ Too much pressure or too little pressure risks cracking the sheet.
- ✓ Complete the cut before stopping.

For thicker than 10 mm polycarbonate sheets; it is recommended to use circular saw for cutting thick polycarbonate multiwall sheets.

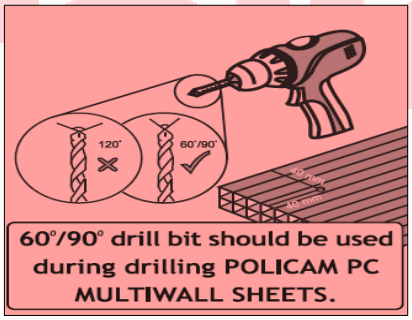
After the cutting operation, you should clean the small particles and chips which have entered the flute channels.

7.2. Drilling

- You can use drill bits intended for metal, for drilling operations of Policam™ Polycarbonate Multiwall Sheets.
- It is recommended the hole diameter should be **2 mm larger** than that of the screw used. As when cutting, always support the sheet in the vicinity of the place being drilled and clean away the sawdust and shavings, both on and inside the sheet.
- Drill all the required holes perpendicular to the face of the sheet.



- Drill with a high-speed steel or carbide tipped twist drill. 60° and 90° drill bit should be used for drilling.



7.3. Installation

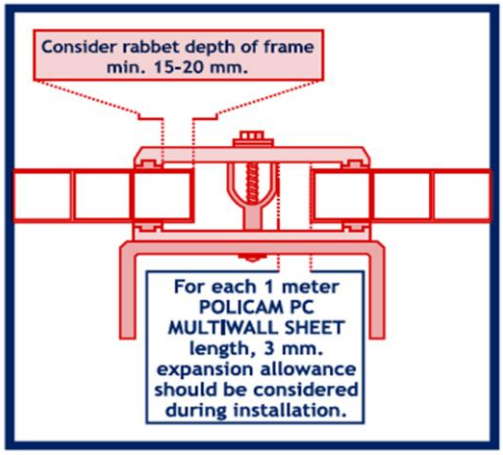
- When sheets are ready for installation, it is highly recommended to consider thermal expansion of polycarbonate and allowing for free expansion of the sheet to prevent bowing and internal thermal stress.

The linear thermal expansion coefficient of polycarbonate is a = 0.065 mm/mK = 6.5x 10^{-2} mm/mK

Example:

- Sheet size 2050*6000 mm (2 x 6 m)
- Expected highest temperature= 40°C
- Expected lowest temperature =-5°C
- Temperature difference Δt =45°C
- Expansion in width=0.065*45*2=5,85 ~ 6mm
- Expansion in length=0.065*45*6=17,55

So it is recommended allowing for expansion of 3mm/m



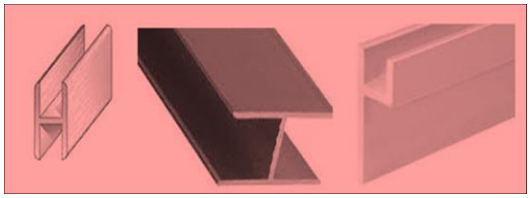
- **Rabbet Depth:** For good and a proper installation of Policam™ Polycarbonate Multiwall Sheets the clamping profiles must have a correct rabbet depth design.

Sheet Thickness Required for Given Sheet Width and Rabbet Depth Table:

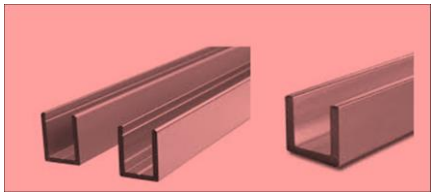
Width	Thickness	Rabbet Depth
700 mm	3 mm	15-20 mm
900 mm	4 mm	15-20 mm
1100 mm	5 mm	15-20 mm
1300 mm	6 mm	20-30 mm
1500 mm	8 mm	20-30 mm
1700 mm	10 mm	20-30 mm
1900 mm	12 mm	20-30 mm
2100 mm	16 mm	20-30 mm

- **Installation direction:** Policam™ Polycarbonate Multiwall Sheets have a coextruded UV Protective Layer at one side. This UV side comes as masked with a printed protective film. The sheets have to be installed always the UV side facing upwards/outwards turned towards the sun. Also customers may order both side UV protected sheets.

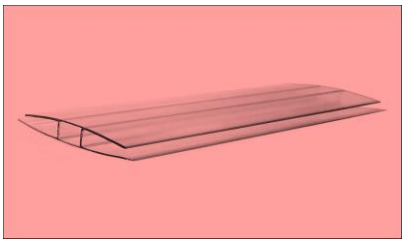
- **Profile Types:** There are different aluminum profiles and polycarbonate connectors for various applications in the market. Aluminum profiles with EPDM rubbers are most common types for multiwall sheets. .Aluminum H -Profile, Aluminum U Profile, Polycarbonate U Profile, Polycarbonate H Profile, Polycarbonate R Profile etc. Actually any construction can be used with considering characteristics of polycarbonate. For getting optimum load carrying capacity all the edges should be clamped properly and proper rabbet depth should be considered



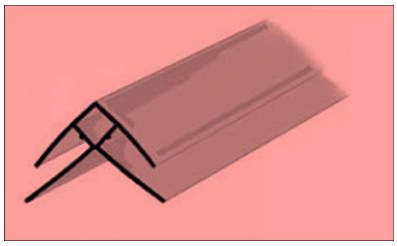
Aluminum H Profiles



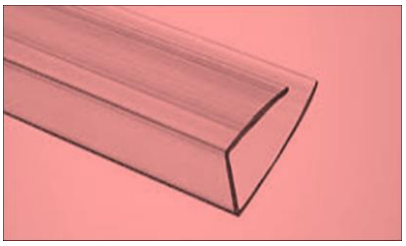
Aluminum U Profiles



Polycarbonate H Profile



Polycarbonate R Profile



Polycarbonate U Profile