Fabrication Guide

by PLASKOLITE, INC.

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Mustang™ Copolyester Sheet

Plaskolite is a leading manufacturer of acrylic sheet, acrylic resin, polystyrene sheet, acrylic mirror sheet products, and Mustang copolyester sheet. Since 1950, it has built an excellent reputation for providing superior quality products and responsive customer service.

Plaskolite's commitment to quality extends over every aspect of its business. From the manufacturing/distribution headquarters in Columbus, Ohio, and manufacturing/distribution facilities located in Zanesville, Ohio; Compton, California; Grand Saline, Texas; Olive Branch, Mississippi; and Monterrey, Mexico, as well as additional distribution facilities located in Riverside, California, and Doesburg, Holland, Plaskolite delivers exceptional quality plastic sheet and resin to its customers worldwide.

To better serve customers, sheet can be ordered in customized "run-to-size" dimensions, special patterns, and thicknesses. Inside sales representatives use automated order and shipping tracking systems to provide customers with up-to-the-minute order information.

From manufacturing, through customized product offerings, packing, shipping and order tracking, Plaskolite is committed to delivering the highest quality products and service.

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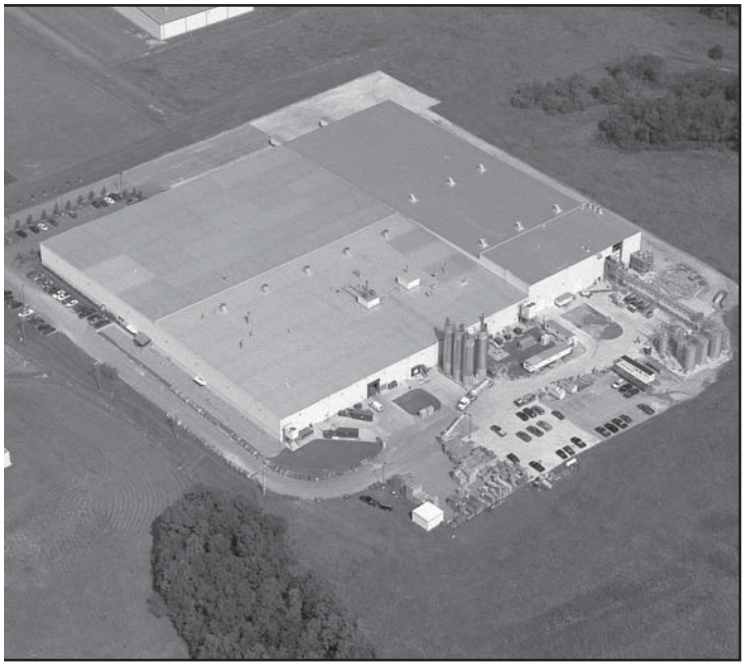
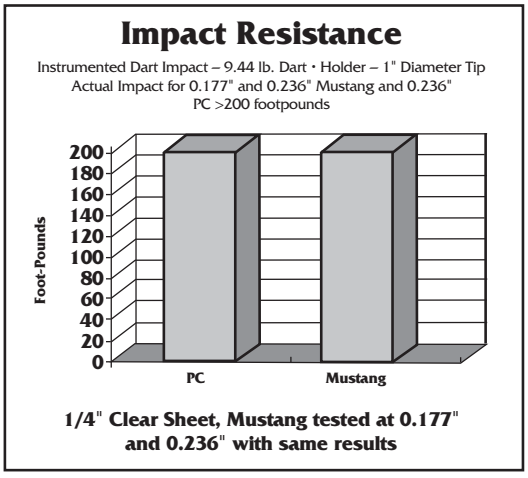
Columbus, Ohio. ISO9000/2000 Certified, Quality Management System



Zanesville, Ohio. ISO9000/2000 Certified. Quality Management System



Graph 1

Physical Properties

Plaskolite's Mustang is a continuously extruded sheet product manufactured with Eastman Tritan™ copolyester. It is a clear, tough, easily thermoformed and weather resistant (with UV cap layer technology) sheet material. Mustang copolyester sheet comes in only one grade: TOUGH! It is readily available in clear and white, with colors available upon request. Available in a sheet thickness range from 0.100" to 0.250" with widths up to 105".

Mustang's strength and clarity make it ideal for demanding applications, including signage and glazing. Its strength and versatility provides ease in fabrication using many techniques, including thermoforming, cutting and routing. Due to the low heat requirement to form, Mustang sheet can be thermoformed after decoration with vinyl graphics and screen inks.

Mustang sheet is manufactured using Eastman Tritan™ GX 100 resin and GX100 meets Underwriters Laboratories requirements UL 94 HB, UL 879 Sign Components and UL 48 Electric Signs as a Rigid, Non-Enclosure Sign Face.

Mustang Features

Impact Strength

Mustang sheet's superior strength is comparable to that of polycarbonate (See Graph 1). It's half the weight of glass and significantly stronger than acrylic sheet products.

Mustang Features

Temperature Resistance

Mustang sheet begins to soften between 210-215° F. This allows for ease in thermoforming and compatibility with sheet pre-decorated with vinyl and/or paint. In sheet form, it can withstand temperatures down to -30° F without any noticeable changes in impact properties[1]
It has a heat distortion temperature equivalent to that of acrylic sheet, making it ideal for outside applications.

Light Transmission

Mustang sheet has a light transmission of 89% and a haze of 1% or less.

Weather Resistance

Mustang sheet is recommended for indoor or outdoor applications. Manufactured with proven UV protective layer technology, which provides excellent weatherability and filtering of damaging wavelengths in the area of 250 –390 nanometers (See Graphs 2 & 3). The masking on the sheet side with the UV protective layer is clearly labeled and should always be fabricated to face the sun in the finished application. Discoloration of plastic can also be caused from atmospheric contamination and particles, this damaging effect can be minimized by regular cleaning of the finished product.

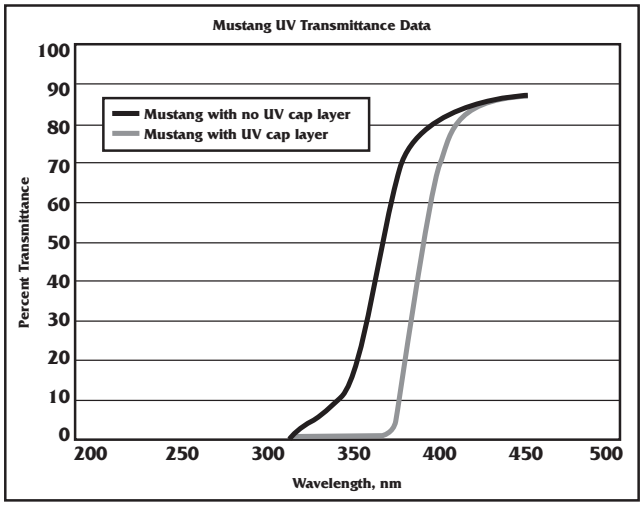
Forming Benefits

Mustang sheet has a wide thermoforming window and is exceptionally easy to form. Compared to polycarbonate, it has shorter heating and cooling cycles, better forming detail, improved material distribution, and much better compatibility with vinyl and paint. **Due to the low temperature required to thermoform, and the shorter heating and cooling cycle times, Mustang sheet pre-decorated with vinyl and/or screen inks can be easily formed.**

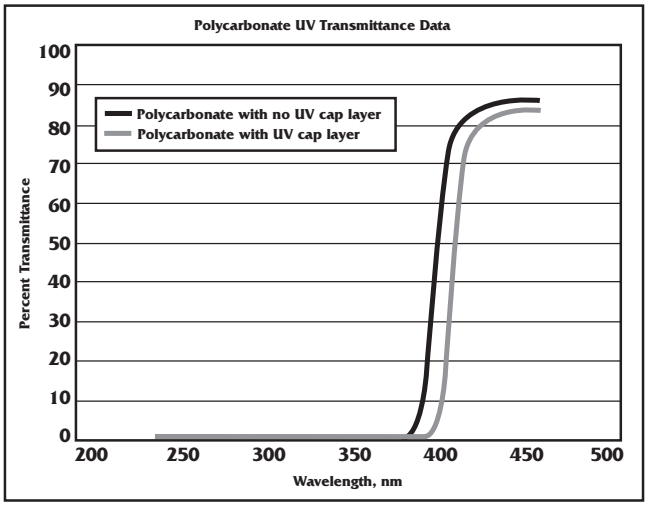
Mustang sheet does not require pre-drying, which allows for significant savings in energy, labor and production costs.

Scratch Resistance

The scratch resistance of Mustang sheet is not as high as acrylic but is comparable to that of polycarbonate. Care should be used when handling the sheet during the fabrication process.
It is recommended that the protective masking remain on the sheet as long as possible.



Graph 2



Graph 3

[1] ASTM D3763 - High Speed Puncture Properties of Plastics

Mustang Features

Mustang Sheet/Sign Grade Polycarbonate Physical Properties

Property	Test Method	Unit	Mustang	Sign Grade Polycarbonate
Specific Gravity	ASTMD792	–	1.18	1.20
Light Transmission@.118" thickness	ASTMD1003	%	85	87
Rockwell Hardness	ASTMD785		M34, R119	M70,R118
Mechanical				
Tensile Strength, ultimate	ASTMD638	psi	7,200	9,500
Tensile Modulus	ASTMD638	psi	230,000	285,000
Flexural Strength	ASTMD790	psi	9,500	13,500
Flexural Modulus	ASTMD790	psi	230,000	340,000
Compressive Strength	ASTMD695	psi	14,300	12,500
Izod Impact Strength, up to125mils, notched	ASTMD256A	Ft-lb/in	19-20	12–16
Izod Impact Strength, up to125mils, unnotched	ASTMD256A	Ft-lb/in	No break	--
Drop Ball Impact Strength, 1"dia.dart@.236thickness	Non standard	Ft-lb		
@73° F			>200	> 200
@0° F			>200	Not tested
Thermal				
CoefficientofThermalExpansion	ASTMD696	in/in/°F	$3.9x10^{-5}$	$3.75x10^{-5}$
HeatDeflectionTemperature	ASTMD648	°F (°C)		
@264psi			194(90)	260 (127)
@ 66psi			210(99)	280(138)

Mustang/Polycarbonate General Comparisons

Feature	Mustang	Polycarbonate
Pre-Dry Sheet	No	Yes
Weathering	Uses coextruded UV cap layer technology	Uses coextruded UV cap layer technology
Forming Temperatures	310-360°F	350-400°F
Degree of Forming Detail	Excellent	Good
Specific Gravity (g/cc)	1.18	1.20
Forming with Vinyl	**Excellent**	Difficult

Mustang Care

Safety Concerns

Mustang sheet, like other thermoplastic sheet materials, is combustible. Do not place or store in or near open flame or other sources of ignition. Always consider fire precautions when working with thermoplastic sheet materials.

Storage

It is recommended that Mustang sheet be stored horizontally, on the supplied flat bulk skids, in a well-ventilated, constant temperature environment. Avoid storing in areas where the temperature could exceed 100° F.

A-frames or special racks can be used to store the sheet vertically. The rack construction should allow the sheet to lean approximately 10°.

Handling

Mustang sheet is covered with a film masking, providing minimal scratch protection to the sheet surface area. Care should be taken when handling, as wood surfaces, dirt, chips of wood, and metal can tear the masking exposing the sheet to possible damage.

Masking Removal

The protective masking can be easily removed. Start at a corner and peel back at an approximate 45° angle. The buildup of static charge is possible, and may cause small shocks to the person removing the masking. Wiping the surface area of the sheet with a damp cotton cloth can reduce the amount of static charge.

Cleaning

Mustang sheet, like all plastics used in sign faces, needs to be and should be cleaned periodically (1-2 times/year). A regular cleaning program will help minimize any visible weathering of the sign face from dirt, grime, rain, and other natural elements.

For general cleaning, it is recommended that the following instructions be used:	
1	Rinse sheet with lukewarm water.
2	Wash sheet with a mild solution of liquid dish detergent in water.
3	Use a soft cotton cloth to gently wash the sign face.
4	Rinse thoroughly with clean cold water.
5	Avoid the use of abrasive cleaners, squeegees and/or other cleaning implements that may mar or gouge the sheet.

For more heavily weathered sign faces, rinse first, then use Formula 409® with a soft cotton cloth, then rinse with clean water to remove the cleaning agent as quickly as possible.

The following cleaning products have been found to be compatible with Mustang under laboratory conditions.*	
Joy®	VM&P Naphtha®
Palmolive® Liquid	Windex®
Lemon Cascade®	Soft Scrub®
Isopropyl Alcohol (mixed 1:1 with clean water)	

* Plaskolite cannot guarantee that actual end-use conditions have been duplicated. Therefore, these results should be used as a guide only and it is recommended that the products be tested under actual end-use conditions by the user. When using these products, do not allow them to remain on the sign face longer than it takes to remove the dirt, grime, or other deposits. Immediately remove the cleaning agent with a soft clean cotton cloth.

Cutting/Machining

Cutting

Because of its excellent strength and flexibility, Mustang sheet cannot be broken using a scribe and break technique. It must be cut completely through. Cutting can be done with a variety of devices such as table and panel saws, circular saws, jig or saber saws, band saws, table and hand routers, CNC routers, and roto-zip tools. If Mustang sheet chips or cracks during the cutting and trimming process, it is most likely due to worn, dull blades and bits. Always use clean, sharp cutting equipment and make sure the sheet being cut is adequately secured to prevent vibrations of the sheet during the cutting process.

Table and panel saws are the best options for high volume straight cuts. Mustang sheet can be stacked to cut several sheets at one time, but the stack must be held securely to prevent movement. When cutting, the saw blade should protrude through the top of the sheet 1/8"-1/4" (See Figure 1). Saw blades specifically designed for cutting plastic sheet are commercially available. Those with triple chip grind teeth are preferred. (See Figures 2-3).

Cutting/Machining

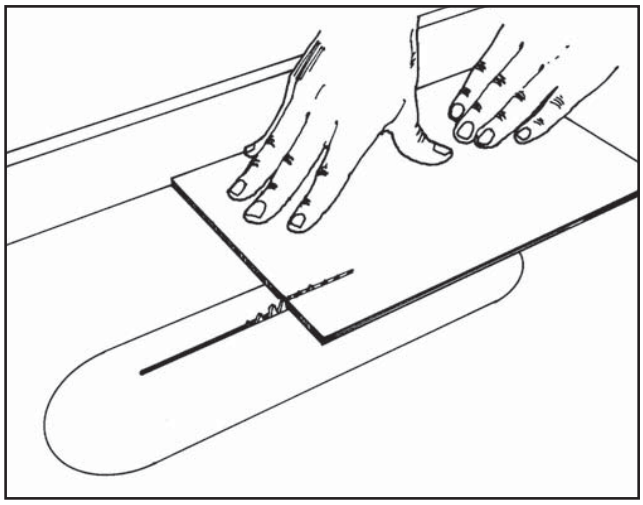


Figure 1

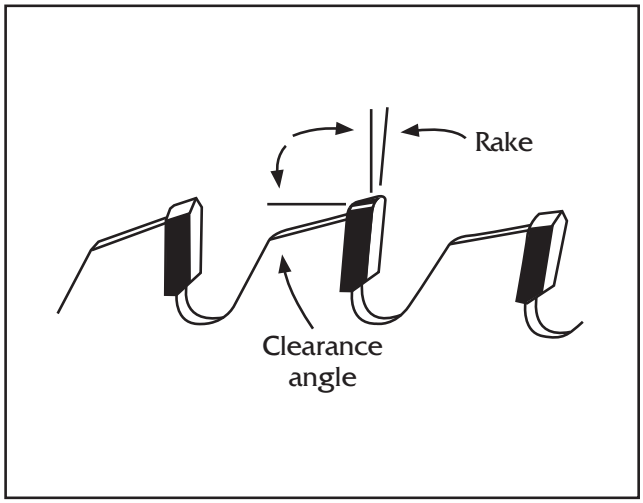


Figure 2

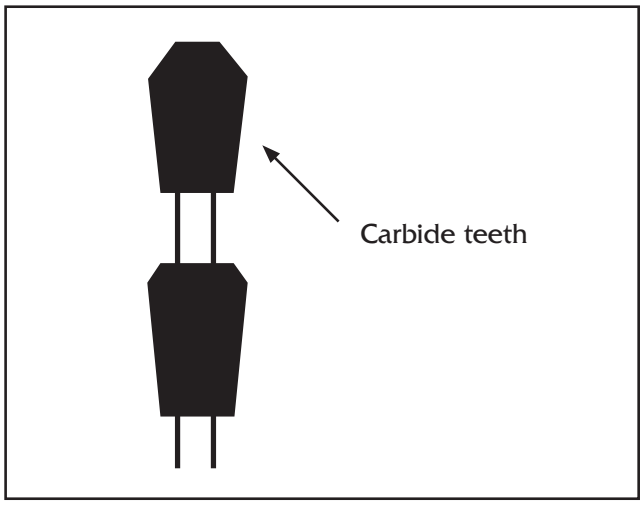


Figure 3

Blade Diameter (in/mm)	RPM
6 (152)	6400
7.25 (180)	5000
8 (200)	4300
10 (250)	3400
12 (300)	2900
14 (350)	2500

Circular Saw Blade Specifications	
Number of teeth	3-4/inch (25mm) >1/8" (3mm) thickness
	8-10/inch (25mm) < 1/8" (3mm) thickness

Routing is a versatile method for cutting and trimming Mustang sheet. Bit selection is important and those specifically designed for plastics are commercially available. Carbide bits with sharp one to two fluted designs work very well. The number of flutes depends on the diameter of the bit and the speed (rpm) of the router. In general, use single fluted carbide tipped bits for bit diameters ≤ 3/8" and double fluted carbide tipped bits for larger bit diameters.

Chipping and cracking of the sheet edges can occur if the correct router settings are not observed. This may be detrimental to the physical properties of the sheet. Please see the Troubleshooting Guide on page 15 for additional information.

Other Types of Saws

Band Saws: Use blades with 8-14 teeth/inch for general cutting: 18-25 teeth/inch when smoother cuts are necessary.

Saber or Jig Saws: Use blades with 8-10 teeth/inch. Ensure that your sheet material is securely fastened to prevent vibration during the cutting process.

Kett Saws: Blade #157-66, 2.5" diameter, 60 teeth. Rate of cut will determine quality of cut.

Roto-Zip Type: ZB10 bit for small trim of ≤ 0.150" sheet. For thicker sheet, use Onsrud #52-624.

Cutting/Machining

Drilling

Drilling holes is performed best on a drill press with commercially available plastic cutting drill bits. The bit diameter should be used to determine the appropriate drill speed (See Table 1).

Bit Diameter (inches)	Speed (RPM)
1/8	3500
3/16	2500
1/4	1800
3/8	1200
1/2	900
5/8	700

Table 1

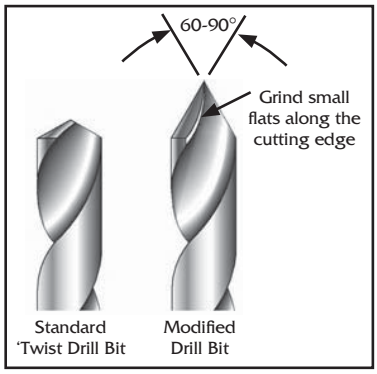


Figure 4

Place a scrap piece of plastic sheet or plywood under the sheet that is being drilled. This will eliminate the possibility of chipping as the bit passes through the other end. Standard twist drills can be used, provided modifications to the drill bit are made. These modifications will allow the bit to scrape rather than cut through the sheet (See Figure 4).

Regulate the speed of drilling to obtain a continuous spiraling chip. Use air or a cool water mist spray if needed. Avoid cutting oils as they may cause crazing around the drilling area. Refrain from creating notches in the drilled areas as notches and crazing may cause premature failure of the sheet or fabricated part.

Cutting and Drilling Tips

For optimum cutting and drilling quality, the below guidelines should be observed:

- Use sharp blades/bits/tools reserved for cutting plastic sheet
- Use proper and constant feed rates and RPMs
- Prolong tool life by using the fastest rate of cut to achieve the desired edge or cut quality
- Always clamp the sheet being fabricated to eliminate vibration which could possibly cause chipping or cracking during cutting/drilling
- Compressed air or a fine water mist may be used if necessary to minimize heat buildup during the cutting and trimming processes

Edge Finishing

When edge finishing is required, mechanical edge finishing with diamond cutting wheels provide excellent results. If further edge quality is required, flame polishing may be the preferred technique (remove masking prior to flame polishing).

Bonding Mustang to Itself

Two-part adhesives are recommended when bonding Mustang to Mustang. Solvent bonding similar to the technique used when bonding acrylic parts is not recommended. There are several adhesives that have been found to work well with Mustang sheet. The following have been evaluated and work well with Mustang sheet. In order of effectiveness:

- Weld-On #55
- Lord Adhesives #7542 A/B
- Flex Welder 14345
- Lord Adhesives #403/19
- Lord Adhesives #406/19
- Lord Adhesives #406/17
- Plastic Welder II #14340
- Cybercryl #812
- Weld-On #58

Two-sided pressure sensitive tapes such as 3M VHB bonds well to Mustang.

Cutting/Machining

Adhering Mustang to Other Materials

Care should be taken when bonding Mustang to other materials. Slight differences in thermal expansion and contraction characteristics could place a large concentrated stress on the bonded area. If Mustang must be bonded to dissimilar materials, bond as small an area as possible using adhesives that remain flexible after curing.

Below are recommended adhesives for bonding Mustang to other materials. In order of effectiveness:

Mustang to Polycarbonate	Mustang to Acrylic
Lord 7542 A/B	Lord 403/19
Weld-on #58	Lord 406/19
Loctite 3922	Loctite 3922
Loctite 3321	Loctite 3106
Loctite 3106	Loctite 3321
Dymax 3094	Dymax 3094
Lord 406/19	Lord 7542 A/B
Dymax 3015	Bondmaster V5004
Plastic Welder II #14340	

The adhesives listed for Mustang to Mustang, and for bonding Mustang to other materials, have been evaluated and are recommended. For best results, please follow the guidelines for use from the adhesive manufacturers.

Mechanical Fastening

Attaching Mustang sheet to itself and other substrates can be accomplished with various types of mechanical fasteners. However, when exposed to fluctuating temperatures, allowances for expansion and contraction must be included. Drilling oversized holes, using rubber-coated washers and spacers to distribute localized stress and to act as a cushion to the fastener, as well as not overtightening the fasteners, will allow the sheet to move and assist in the prevention of premature failure at the bonded area. Use only non-rusting fasteners, such as aluminum pop rivets, and space the mechanical fasteners far enough apart to avoid localized overstressing in the attached area, but still close enough to carry the expected load.

Decorating

Mustang sheet can easily be decorated using sign paints manufactured for use on plastics. Follow the paint manufacturer's guidelines for optimum results. Always use proper fabrication guidelines prior to painting and make sure that the Mustang sheet is clean of dust, dirt, grease, oily residues, and grime. All of these will affect the level of paint adhesion and the performance of the finished product. A 1:1 mixture of water and isopropyl alcohol works well for the oily residues that are resistant to mild soapy water. Use a soft cotton cloth to rub lightly and dry.

Mustang sheet works exceptionally well in pre-decorated applications where thermoforming is necessary. Because pre-drying isn't required, the lower thermoforming temperatures, improved material distribution and stretching characteristics, Mustang sheet is fully compatible with vinyl and screen inks that are designed for themoformed signs.

When using the spray and cut masking technique, care should be taken not to cut the Mustang sheet surface when cutting through the masking. This could cause notches, which may result in premature failure of the sheet or fabricated part. It is suggested that the blade tip of the cutting instrument be rounded to prevent accidental notching.

Paint typically reduces the impact strength of all plastics. Design considerations should be taken into account to minimize the potential for cracking and possible breakage of the finished part.

General guidelines include:

- Avoid too wet a mist when spraying
- Allow proper drying time between coats of paint (refer to paint manufacturer's recommendations)
- Avoid application of heavy wet coats of paint during each application
- Use dry air during the spraying process as water can affect the adhesion and strength of the paint film
- Avoid high humidity areas during the paint curing process

Cutting/Machining

- Do not blend paints from different manufacturers
- Do not use an overly thick layer of paint to obtain opacity. It is better to use several thin layers to achieve this result

Paint Removal

When paint removal is required, remove as soon after painting as possible. A paint thinner may be used; however, review the paint manufacturer's recommendations prior to applying. Always minimize the time solvents are in contact with plastic sheet.

Vinyl Films

Lettering and intricate designs made with vinyl adhere well to Mustang sheet. They can be applied either wet or dry, depending on the preference of the operator. Due to the low temperature required to thermoform, the stretching characteristics, and Mustang's overall thermoforming superiority to other plastic materials, a sheet pre-decorated with vinyl can be thermoformed for distortion forming applications. **The unique process of forming a pre-applied vinyl on the second surface is an option with Mustang, with the only limitation being the vinyl's ability to stretch. This process is not done on other sign plastics.**

Vinyl Weeding

Mustang sheet is an excellent material for vinyl decoration, both prior to and after thermoforming. As with other plastics, the sheet needs to dry overnight to allow the moisture to escape from between the Mustang and the vinyl. If using multiple layers of vinyl decoration, additional time may be required.

The thermoforming temperatures for Mustang are compatible with those of vinyl, allowing more even vinyl stretching characteristics and less chance of vinyl blistering.

Use caution when removing (weeding) the excess vinyl from a pre-decorated, thermoformed sign face. The below steps are suggested when using and weeding vinyl from a formed face:

- Apply vinyl per the manufacturer's recommendations
- Generally, it is best to weed vinyl as soon after forming as possible
- Allow Mustang sheet to cool a minimum of 1 hour to room temperature prior to weeding
- Do not allow the knife used to weed penetrate the surface of Mustang
- Once the weeding process has begun, pull the vinyl in smooth, even motions. Removing too rapidly could cause the vinyl to tear
- Use both hands to pull the vinyl from Mustang at an approximate 70-80 degree angle. Pulling at a 45 degree angle is more difficult and increases the chance of vinyl tearing

Second Surface Vinyl Weeding

- When applying and thermoforming second surface vinyl (applied to the non UV side of the sheet), the vinyl must be weeded before it cools completely. Complete cooling generally occurs within 5-10 minutes after forming. Ideally, weeding should take place as soon as the vinyl has the integrity to do so.
- If weeding the second surface vinyl isn't possible prior to complete cooling, reheat the area of vinyl where weeding is necessary using a small hand-held propane torch, using the "fanning" attachment. Take care not to burn or blister the vinyl during this process.

Forming

Cold Bending

Although no plastic sheet should be cold bent to any severity, a bend in Mustang can be achieved without applying heat. A minimum radius of at least 100 times the initial thickness of the sheet is required.

Brake Bending

Brake bending is not recommended when fabricating plastic sheet. However, if this type of fabrication is necessary, do not perform on Mustang sheet >0.100" (2.5mm) thickness. Heat bending should be used on thicker gauges. Brake bending creates high levels of stress in the bend area, and could result in cracks and breakage during this process, or at a later time.

Forming

Line Bending

Line bending, also known as strip heating, is a technique used for forming sharp bends in the plastic sheet. When heated properly, Mustang lends itself well to this type of fabrication. The radius of the bend can be controlled by the width of the heated area. The temperature of the side opposite of the heat source should be heated to ≥250° F prior to bending. This will assist in eliminating the residual stress that can form when bending at a temperature that is too cold. Thicker sheets should be heated from both sides to achieve a uniform heating through the sheet. Heat perpendicular to the manufacturer's extrusion direction to reduce the possibility of warpage in the heated areas. Always stabilize the sheet by clamping during the heating and cooling processes.

Oven Heating

Mustang sheet should be heated in a horizontal oven. It is not conducive to use with vertical ovens.

Thermoforming

The term thermoforming refers to the process of heating a plastic sheet to sufficient temperature to form a shaped article. Mustang sheet excels in this area, offering a unique combination unmatched by polycarbonate. Mustang sheet can be thermoformed without pre-drying, forms at lower temperatures, has faster heating and cooling cycles, has excellent material distribution characteristics and processes consistently. Deep draws and intricate part definitions are achievable with Mustang by using simple vacuum forming techniques.

The entire cut to size sheet is typically heated to forming temperature inside an oven. The forming temperature depends on the thickness of the sheet and the shape or complexity of the mold (See Table 2). For less intricate molds, heat Mustang sheet on the lower side of the temperature range. For deeper draws and more complicated mold designs, heat to the middle to upper side of the temperature range. Because Mustang sheet exhibits great detail, care should be taken when manufacturing the mold. It needs to be smooth. Mustang sheet will form to the details of a rough mold (mold mark-off).

The radii of the finished part should be greater than or equal to the initial sheet thickness. This will greatly reduce stress molded into the part due to sharp radii (See Figure 5). Sharper corners increase the localized stress, which could lead to micro cracks, and then to possible part failure.

During the cooling process, a thermoformed part should be fully supported as additional shrinkage may occur. The extrusion direction of the sheet is the most susceptible to shrinkage. Supporting will reduce the possibility of warping of the final part, especially in the flange area.

Thermoforming Temperature vs Sheet Thickness
Mustang Thermoforming Conditions: 0.118 to 0.177 thickness

Property	Mustang Conditions		
	0.118	0.150	0.177
Optimal Forming Temperature Range (°F)	310-340	320-350	330-360
Optimal Forming Temperature (°F)	325	340	350
Heating Time with One Sided Heating Oven	4-5 minutes	4-5 minutes	4-5 minutes
Molded Part Release Temperature (°F)	180-185	180-185	180-185
Optimal Mold Temperature (°F)	180	180	180
Typical shrinkage factors			
MD	<5%	<4%	<3%
TD	± 0.5%	± 0.5%	± 0.5%

Table 2

Thermoforming temperatures were generated from 24" x 36" frame using top heating elements only. Temperatures were measured from the top of the sheet using a water cooled IR temperature detector. Oven settings were changed to achieve 4-5 minutes heating time. Field testing has indicated the optimum temperatures are slightly lower than those shown here.

Forming

Stresses Created Compared to Radius of Corners

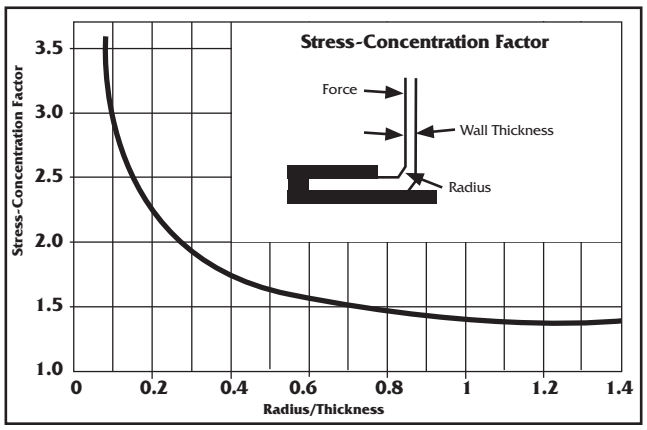


Figure 5

Free Blown Forming

This is done by clamping the heated Mustang sheet and blowing upward with compressed air similar to blowing a bubble. The reverse can be accomplished by drawing the sheet into a chamber using vacuum pressure

Availability and Transportation

Mustang is available in flat sheet or roll stock. If cutting from reels, do not re-roll to less than 50" diameter. Sheet should be handled standing on edge. Protect the entire sheet from scratches with shrink wrap or other protective source.

Forming and Annealing

Mustang sheet cut from reels can be thermoformed without annealing. However, if a flat sign will be manufactured from Mustang cut from rollstock, annealing is recommended. Annealing can be accomplished by placing the sheet in a forced air oven at 165° F for 2-3 hours and allowing it to cool to at least 120° F prior to use.

Uniform Load	Apprroximate Wind Velocity
20 PSF	75 MPH
30 PSF	90 MPH
40 PSF	100 MPH
50 PSF	130 MPH

Table 3

Selection of Sheet Thickness

Determining proper sheet thickness is based on the short dimension of the sign and the specified maximum wind load in pounds per square feet (PSF) (see Figure 6). The sign is required to meet a specified wind load determined by building codes of your area. Approximate wind loads in relation to wind velocity can be seen in Table 3.

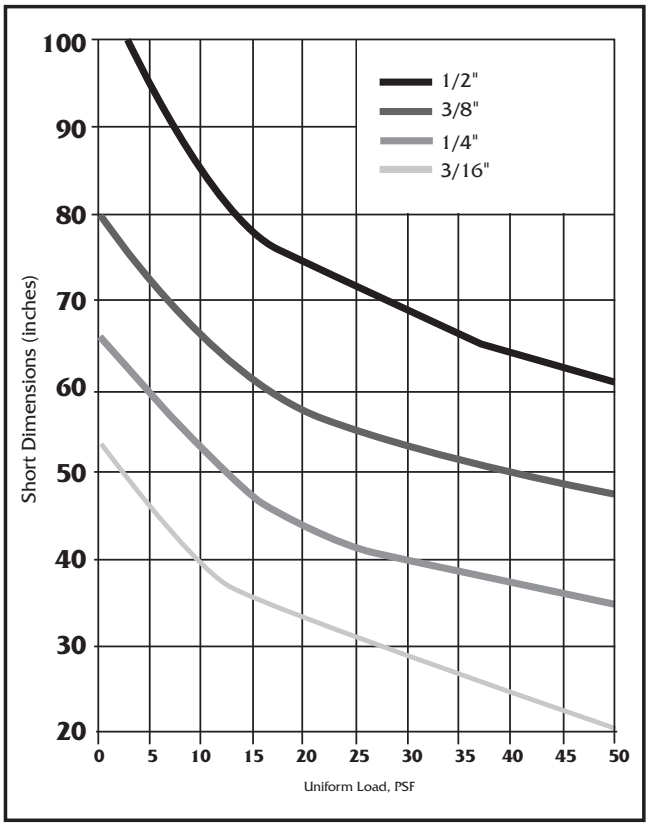


Figure 6

Sheet Size

Expansion and contraction allowances must be taken into consideration when fabricating signs for outdoor applications. Mustang sheet, like all plastics, must be allowed to move within the confinements of the sign channels to prevent bowing or dislodging. The coefficient of linear thermal expansion (COTE) is 3.9×10^{-5}. This number can be used to calculate the necessary dimensions needed to allow the necessary movement of the plastic sign face. A simple rule of thumb is to allow 1/16" per linear foot in each direction (width and height).

Sign Assembly

Assembly

Typical sign cabinets use aluminum extrusions to engage the edges or flanges of the Mustang sign face (See Figure 7). A hanger bar (hanging strip, hanging lug, etc.) is used along the top of the Mustang sign to correct any sagging or bowing of the sign face. This technique is commonly used in warmer climates and with large signs to prevent the weight of the sign from resting on the lower portion of the sign can or frame. This reduces the possibility of sign deformation due to high temperatures (See Figure 8).

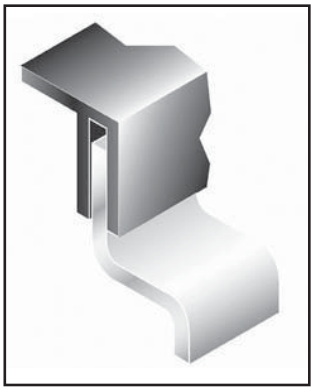


Figure 7

Figure 8

If mechanical fasteners must be used, allow room for expansion and contraction (See Sheet Size information on previous page). A method of attachment to prevent the Mustang sign face from binding on the sign cabinet includes a spacer that is slightly taller than the thickness of the sheet and the sign cabinet combined, inserted through the oversized hole and slot (also called a bushing) (See Figure 9).

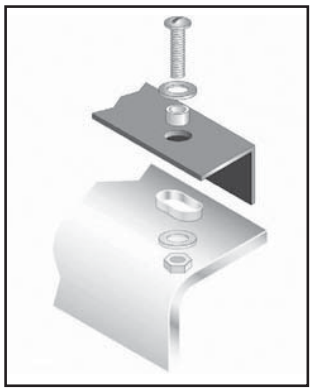


Figure 9

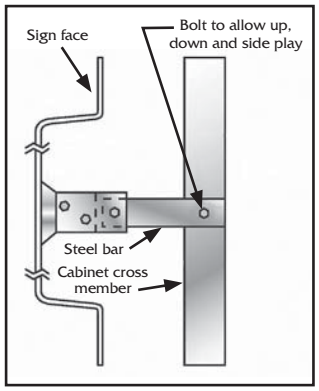


Figure 10

Internal tie bars and soft bumpers are sometimes used to attach a large sign face to the sign cabinet (See Figure 10). This will aid in preventing the sign face from blowing in, out, or dislodging during extreme weather conditions.

Ventilation

To help prevent sign face distortion caused by excessive heat buildup, cabinet ventilation should be provided. Consider additional venting when the sign face is decorated with dark paints or dark vinyl (See Figure 11).

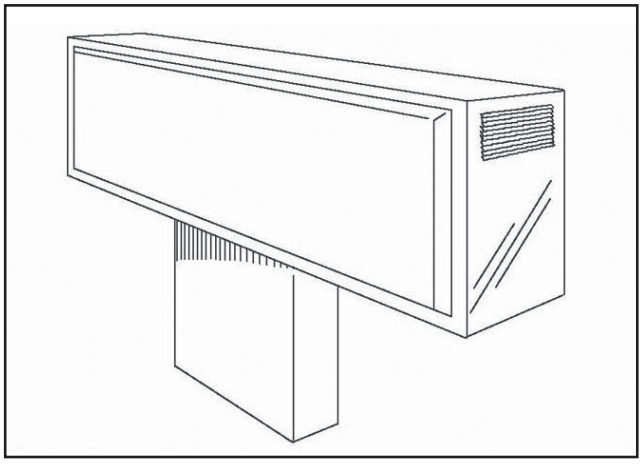


Figure 11

Attachment of Trim Cap

An adhesive must be used to bond Mustang to the cellulosic trim cap material used in the production of channel letters (See Figure 12). Weld-On #55, Weld-On #58, and Lord Adhesives #406/17 have been found to work well with bonding Mustang to the trim cap material.

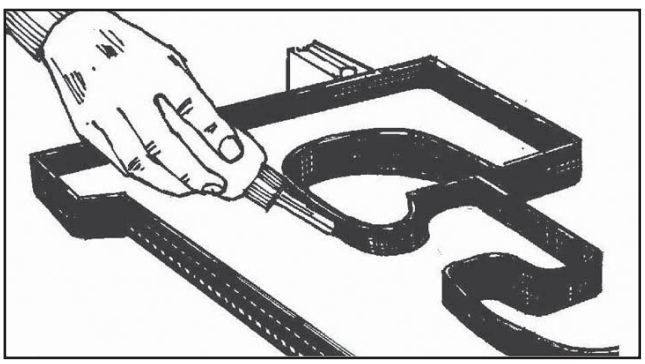


Figure 12

Chemical Resistance

Chemical Resistance of Mustang Copolyester Sheet

Resistant (Compatible)
Acetic Acid (5%)
Oleic Acid
Methyl Alcohol
Ammonium Hydroxide (sg .9)
Mineral Oil
Lipid Solution (2%)
Hydrogen Peroxide (3%)
Ammonium Hydroxide (10%)
Phthalate
Ethyl Alcohol (50%)
Diesel Fuel
Heptane
Hydrogen Peroxide (28%)
Kerosene
Nitric Acid (40%)
Transmission Fluid
Detergent Sol. (.025%)
Transformer Oil
Distilled Water
Cottonseed Oil
Citric Acid (1%)
Turpentine
Soap Solution (1%)
Isopropanol
Motor Oil
Olive Oil
Sod Carb Sol. (20%)
Nitric Acid (10%)
Isooctane
Ethyl Alcohol (95%)
Brake Fluid
Antifreeze

Non-Resistant (Not Compatible)
Ethylene Dichloride
Toluene
Aniline
Ethyl Acetate
Acetone
Dimethyl Formamide
Diethyl Ether
Phenol Solution (5%)
Acetic Acid (sg 1.05)
Gasoline

Troubleshooting Guide

Mustang Thermoforming Troubleshooting

Problem	Possible Cause	Suggested Solutions
Crazed, cracked or brittle parts	• Poor mold design • Sheet forming temp. too low	• Increase mold radii to equal sheet thickness • Increase heat settings and/or time in oven
Webbing during forming process	• Sheet too hot • Complex mold design • Rate of vacuum too fast • Uneven heating of sheet • Poor mold design • Poor mold layout	• Decrease sheet temperature • Use female mold design • Use plug and or pressure assisted forming • Decrease rate and time of applied vacuum • Check oven heaters for “hot spots” or bad elements • Increase radii and draft angles • Spacing between molds should be approximately 2” x depth of draw or height of molded part
Non-uniform sheet sag	• Uneven oven heating	• Check oven heaters and adjust accordingly • Check for colder air drafts around forming area
Poor material distribution	• Uneven oven heating • Uneven clamp pressures • Deep drawn parts	• Check oven heaters and adjust accordingly • Check for air drafts around forming area • Check clamp pressures and adjust • Use plug or pressure assist
Poor detail or part definition	• Sheet too cold • Poor mold design • Insufficient vacuum • Uneven sheet temperatures • Vacuum release too soon • External cooling applied too soon	• Increase sheet temperature • Increase radii, draft angles, spacing, etc • Check vacuum pumps, increase if necessary • Check oven heaters and adjust, Check for air drafts • Increase timing to vacuum release • Increase time prior to external cooling application
Poor surface finish/ defects/pin-holing	• Dirty mold • Mold surface defects • Vacuum holes too large • Vacuum rate/amount too high • Mold mark-off	• Clean mold with air/damp dust free cloth • Sand and/or polish mold surface • Decrease size of vacuum holes • Decrease rate and/or amount of vacuum • Vapor hone or lightly sand mold surface
Sticking to mold	• Draft angle too small • Radii too small • Mold too hot	• Increase draft angle >= 5° • Increase radii to equal sheet thickness • Reduce mold temperature if possible • Use talcum powder to dust mold
Voids or bubbles in sheet	• Sheet too hot • Excessive sheet moisture	• Decrease heating time and/or oven temperature • Increase distance from heating elements • Dry sheet @ 80 °C, 2-4 hours • Store sheet under dry conditions (inside)
Part warpage	• Insufficient cooling of part • Mold too cold	• Allow part to cool longer prior to mold release • Wait longer time prior to cooling fan activation after forming • Increase mold temperature to allow slower cooling
Material pulling from frames	• Sheet too cold • Insufficient/uneven clamp pressure	• Increase sheet temperatures • Increase/equilibrate clamp pressures
Trimming difficulties	• Improper blade selection • Incorrect blade speed	• Routers: Slotting cutter, carbide tipped, 0.062 decimal kerf, 4-wing (i.e. Whiteside Part# 6700B) • Table Saws: See Table Saw section - pages 5 & 6 • Band Saws: See Band Saw section - page 6 • Routers: Use 20-25,000 RPM Router speed
Chipping/cracking during cutting	• Inadequate clamping of parts • Saw blade tooth gap too large • Dull blade or shear	• Increase/equilibrate clamp pressure • Choose blade with more teeth/inch • Replace blade/sharpen shear

Troubleshooting Guide

Mustang Circular Saw Troubleshooting

Problem	Possible Cause	Suggested Solutions
Softened edges	• Blade speed too fast • Sheet feed rate too slow • Blade tooth size too small • Blade too hot • Dull blade • Too many sheets in cutting stack	• Reduce blade speed • Increase sheet feed rate • Increase blade tooth size • Use cool air on blade duing cutting • Sharpen blade • Reduce the of sheets in cutting stack
Chipping of sheet	• Sheet is not properly clamped • Sheet feed rate too fast • Dull blade • Blade is not installed properly • Blade tooth size is too large	• Clamp sheet securely to minimize vibrations • Reduce sheet feed rate • Sharpen blade • Ensure blade is properly installed and free of wobble • Reduce blade tooth size

Suggested Vendors

Adhesive Manufacturer	Product
IPS Corporation (800) 421-2677 455 West Victoria Street Compton, CA 90220 www.ipscorp.com	Weld-On #55 Weld-On #58
Lord Corporation (877) 275-5673 2000 West Grandview Ave. Erie, PA 16514 www.lord.com	Lord 7542 A/B Lord 403/19 Lord 406/17 Lord 406/19
Dymax Corporation (860) 482-1010 318 Industrial Lane Torrington, CT 06790 www.dymax.com	Dymax 3094 Dymax 3015
Henkel Loctite Corporation (800) 562-8483 1001 Trout Brook Crossing Rocky Hill, CT 06067 www.henkel.com	Loctite 3922 Loctite 3321 Loctite 3106
ITW Devcon (800) 626-7226 30 Endicott Street Danvers, MA 01923 www.devcon.com	Plastic Welder II #14340
National Adhesives (800) 797-4922 10 Finderne Avenue Bridgewater, NJ 08807 www.nationaladh.com	Bondmaster V5004
Paint/Ink Manufacturer	**Product**
Akzo-Nobel, Inc. (770) 662-8464 3669 Old Peachtree Road Norcross, GA 30071 www.akzonobel.com	Super Gripflex Series T-2003 thinner
Coates Screen, Inc. (630) 513-5348 2445 Production Drive St. Charles, IL 60174 www.sunchemical.com	VAC Series UV cured screen inks C37 Series solvent cured screen inks HG-501 screen inks 305 mesh
Spraylat Corporation (800) 336-1936 716 South Columbus Ave. Mt. Vernon, NY 10550	Paint- White: Lacryl C5-1972 Others: Lacryl 400 Series Thinners: Lacryl 205T Screen inks- Lacryl 800 Series
Nazdar (913) 422-1888 8501 Hedge Lane Terrace Shawnee, KS 66227	Screen inks- Solvent cure: 9700 Series UV cure: 1500 Series

Saw Blade Manufacturer
FS Tool Corp. (800) 387-9723 P.O. Box 510 210 S. 8th Street Lewiston, NY 14092 www.fstoolcorp.com
General Saw Corp. (800) 772-3691 2518 Andalusia Blvd. Cape Coral, FL 33909 www.generalsaw.com
Forrest Mfg. Co. Inc. (800) 733-7111 457 River Road Clifton, NJ 07014 www.forrestblades.com
Router Bit Manufacturer
Onsrud Cutter (800) 234-1560 800 Liberty Drive Libertyville, IL 60048 www.onsrud.com
Amana Tool Corp. (800) 445-0077 120 Carolyn Blvd. Farmingdale, NY 11735 www.amanatool.com
Saber Diamond Tools Inc. (888) 240-4324 101 Saber Parkway Villa Rica, GA 30180 www.saberdiamond.com
Drill Bit Manufacturer
Onsrud Cutter (800) 234-1560 800 Liberty Drive Libertyville, IL 60048 www.onsrud.com
Thermoforming Equipment Manufacturer
PlastiVac, Inc. (800) 432-6328 214 Dalton Ave. P.O. Box 5543 Charlotte, NC 28299 www.plastivac.com
The Shuman Company 3232 South Boulevard Charlotte, NC 28209

These suggested vendors and their products are based on information we believe to be reliable. They are offered in good faith, but without guarantee, as conditions and methods of use of the products are beyond our control. We recommend that the prospective user determine the suitability of our material with the products of the vendors, prior to adopting them on a commercial scale.

Disclaimer

This manual is a general guide for working with MUSTANG™ Copolyester Sheet. Because actual results vary with differences in operating conditions, thickness, color, and composition of the copolyester sheet, nothing contained herein can be construed as a warrant that MUSTANG will perform in accordance with these general guidelines.

Important Notice: Our recommendations, if any, for the use of this product, are based on tests believed to be reliable. The greatest care is exercised in the selection of raw materials and in the manufacturing operations. However, since the use of this product is beyond the control of the manufacturer, no guarantee or warranty expressed or implied is made as to such use or effects incidental to such use, handling or possession of the results to be obtained, whether in accordance with the directions, or claimed so to be. The manufacturer expressly disclaims responsibility therefore. Furthermore, nothing contained herein shall be construed as a recommendation to use any product in conflict with existing laws and/or patents covering any material or use.

Anyone experiencing problems fabricating MUSTANG Copolyester Sheet should refer those questions to the Plaskolite Inside Sales Department at (800) 848-9124.

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MUSTANG sheet is manufactured with

EASTMAN TRITAN copolyester

Plaskolite is a leading manufacturer of Optix® continuously processed acrylic sheet, Duraplex® impact modified acrylic sheet, acrylic resin, polystyrene sheet, Fabback® acrylic mirror sheet and Mustang™ copolyester sheet.

Mustang™ sheet is manufactured with Eastman Tritan™ copolyester resin, which is GREENGUARD certified. Eastman Tritan™ has been tested to stringent indoor emission testing requirements and was found to be a very low-emitting material. GREENGUARD products undergo periodic retesting to ensure they will comply with GREENGUARD emission requirements. Signs manufactured with Mustang sheet for interior applications will benefit from the GREENGUARD Certification of Eastman Tritan™ copolyester resin.

A printable version of the Eastman Tritan™ copolyester resin certification is available at www.greenguard.org.

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