VYCOM®

HDPE

FABRICATION GUIDE

Vycom
801 E. Corey Street
Scranton, PA 18505
P: 1.800.235.8320
F: 570.346.4122

www.vycomplastics.com

All information contained herein is accurate to the best of our knowledge and is provided without liability or commitment whatsoever. All recommendations or suggestion are made without guarantee, since the conditions of use are beyond our control. We recommend that you confirm the suitability of our product by carrying out tests under your local conditions and using your own mechanical equipment.

We disclaim any liability incurred in connection with the use of these data or suggestions. This publication is not to be taken as a license to operate under or a recommendation to infringe any patents. The observance of all legal regulations and patents is the responsibility of the user.

Processing and finishing techniques are presented as "typical." Information contained herein is considered accurate to the best or our knowledge. It is offered for your consideration and investigation, and is not to be construed as a representation or warranty, expressed or implied, for which Vycom assumes any legal responsibility. Our warranties are limited to those expressly stated in the written contracts or in conditions of sale. As conditions and methods of use vary and are beyond the control of Vycom, Vycom disclaims any liability incurred as a result of the use of its products in accordance with the data contained on our physical properties charts or in our manual. No information herein shall be construed as an offer of indemnity for infringement or as a recommendation to use the products in such a manner as to infringe any patent, domestics or foreign.

Contents

Introduction

VYCOM®

VYCOM'S Designboard® family of materials provides a new, trend-setting addition to our color and texture palette. Whether you are looking for rich designer shades or the toughness of HDPE with the brilliance of metal, our product has superior performance. Unlike wood or metal alternatives, our products will not rust, corrode, rot, delaminate, or splinter. With their superior scratch resistance, stiffness, and UV package, Designboard products are ideal for a wide range of applications, from outdoor cabinetry, to POP displays, signage and more.

Designboard can be used indoors or outdoors. It is ideal for wood or metal replacement applications. Designboard is lead and heavy metal free, which allows optimal performance while being environmentally friendly.

VYCOM'S Playboard® family of playground and recreational materials offers a multitude of colored HDPE sheets for modular playground systems, ice rinks, and skate parks. Playboard materials are UV stable, easily cleaned and fabricated and are ideally suited for either indoor or outdoor applications.

VYCOM'S Seaboard® family of marine, RV, and outdoor materials provides superior performance where water, UV exposure, and other harsh elements are present. Unlike wood or metal alternatives, our products will not rust, corrode, rot, delaminate, or splinter. With superior scratch resistance, stiffness, and packages, our HDPE products are ideal for outdoor cabinetry, marine furniture, signage and recreational applications.

Vycom, headquartered in Scranton, Pennsylvania, is a world leader in the production of thermal plastic sheet products, and is dedicated to growth through investing in state-of-the-art processing equipment, developing rigid quality control standards, creating new material formulations, and expanding the physical plant to provide the scope and quantities of materials required by customers' rapidly growing demands. Along with its subsidiary companies, Vycom's physical plant occupies over 1.3 million square feet of production, storage and office space. The plant's annual production capacity is in excess of 300 million pounds.

1

This chapter details various methods of machining Designboard, Playboard and Seaboard as part of processing high-density polyethylene (HDPE) material into its final form. Common metal and woodworking tools and machinery can be used, depending on the specific application for the finished product.

Cutting

Vycom HDPE material can be cut with a table saw, radial arm saw, CNC router, band saw, or panel saw. With any cutting process, the key is good sharp tools and adequate chip removal, which helps eliminate heat build-up. A dull tool or improper feed rate can lead to rough edges and heat build-up to the point where the chips start to melt and refuse. Always cut a test piece prior to a production run.

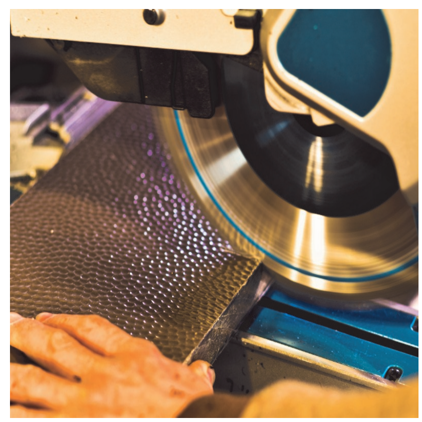

Figure 1a

Circular saws

Generally, carbide tipped blades are recommended. The following settings are useful starting points (Figure 1a);

- **Rake angle: 0° to 15° degrees**
- **Clearance angle: 10° to 20° degrees**
- **Cutting speed: 8,000 to 12,000 feet per minute**
- **Feed: 70 to 90 feet per minute**
- **Tooth pitch: 0.080” - 0.040”**

Band Saws

High speed steel blades normally recommended for wood or plastic (hook type) can be used for HDPE material within the following guidelines.

- **4 to 8 teeth per inch**
- **Cutting speed: 3,000 to 5,000 feet per minute**
- **Feed: Up to 40 feed per minute**

Saber Saws

Rough cut type blades ground for plastics can be used on Designboard, Playboard and Seaboard material. Smooth, metal-cutting blades however, will not produce acceptable results.

Pocketing and Recessed Cutting

The major problem with this type of operation has been the difficulty in obtaining a smooth bottom surface. Even with the relatively flat pointed cutting tools, a series of swirl marks would be evident on the exposed inner material. These swirl marks are the result of raised ridges left by the router bit point, which require time consuming secondary finishing operations to remove. A new style of tool, the **Bottom Surfacing Cutter** developed by Onsrud Cutter, utilizes a nearly flat point with radius corners to create a smooth bottom for this application that requires a high degree of aesthetic appeal in pocketing and recessed areas for hinges and hardware.

Routing

Plastic materials can have a wide variety of machining characteristics ranging from flexible or rigid, and soft to hard. During the routing process, hard plastic forms a splintered wedge or granulated chip, while soft plastic forms a curled chip (Figure 1b). Seaboard, Designboard, and Playboard tend to be soft. This represents a unique set of machining circumstances and tool selection opportunities.

Figure 1b

Tool Selection for General Routing

In the general machining of Seaboard, Designboard and Playboard, the right tool for the job involves the use of up-cut spiral router bits to evacuate chip and maximize finish. The tools of choice include an **Onsrud Cutter 52-080 and 63-725**. These 1/4 inch diameter tools tested in 1/2” Seaboard, Designboard and Playboard provided excellent finish in partial, and full depth cuts. The **52-080** performed best in full depth cuts, while the **63-724** was quieter, which translates into less vibration and heat with increased tool life. The feed rate for the material was 100-200 inches per minute at 18,000 RPM, which reflects a chip load range of approximately 0.006” to 0.011” inches. If the user were limited to a single tool selection, the 63-725 would represent the best all around tool for the job. Both of these router tools, unlike end mills, provide the necessary edge sharpness to alleviate the “fuzzing” or “hairing” sometimes associated with machining this material.

Drilling

In order to prevent chip wrap in soft plastics, and crazing in hard materials, it is recommended that the point angle is set between 90° - 110° degrees (Figure 1c). **Onsrud Cutter** has developed a drill with a 60° degree point and a flat rake face providing the best plunge point in a wide variety of plastics. The point s style creates a chip in soft plastics that is easily ejected and allows the use of normal drilling routines during programming. Material such as polyethylene required a peck drilling cycle to prevent the formation of long chips that would wrap around the drill. The elimination of pecking drilling procedures in a program can lead to reduced cycle time and can increase cutter life significantly.

Figure 1c

TIP	For best results, drill bits should be kept sharp at all times.

- Avoid straight plunge cuts into the material. Program the tool path to ramp into or enter the material from the side providing a path for the chips to be ejected.
- Maximize dust collection to evacuate gummy chip produced by softer plastics.

- As material thickness increases, so should the diameter of the tool. Larger diameters are less susceptible to vibration and afford better chip removal.
- Ensure part rigidity by following proper Spoilboard techniques.

Sanding / Filing (Figure 1d)

HDPE material can be sanded and filed using common woodworking materials and tools. Sand paper grit should be selected based upon on fabrication need. Files with coarse, sharp teeth are recommended.

Figure 1d

Milling

HDPE can be miled by using the following guidelines:

- **Relief angle: 5° to 10° degrees**
- **Rake angle: -10° to 0° degrees**
- **Cutting speed: 3,000 to 3,500 feet per minute**
- **Cutting feed: 0.12” inches per revolution**

Turning

HDPE sheet can be easily machined on lathes using tools that have been ground down to work on plastics, with the following guidelines:

- **Setting angle: 5° to 15° degrees**
- **Rake angle: 0° to 20° degrees**
- **Adjustable rake angle: 45° to 60° degrees**
- **Cutting speed: up to 1640 ft./min**

Plane (Planing)

HDPE material can be easily planed using common woodworking tools, such as a hand plane or power plane, or with large planing machines. There are plane tools specifically produced for use on plastics, such as the **Stanley Bailey Block Plane**.

Fastening

2

In this chapter, various methods of fastening HDPE are covered, as well as important details to consider during the fabrication process. With the numerous uses for HDPE and the differing environments of service, it is important to take into account the material properties during fabrication and installation.

Adhesives

There are many different methods of fastening Seaboard, Designboard and Playboard to various substrates. In some industries, mechanical fasteners using screws, nails or staples are common. However, adhesives can also be an effective bonding tool provided that the correct adhesive is chosen for the applications (Figure 2a).

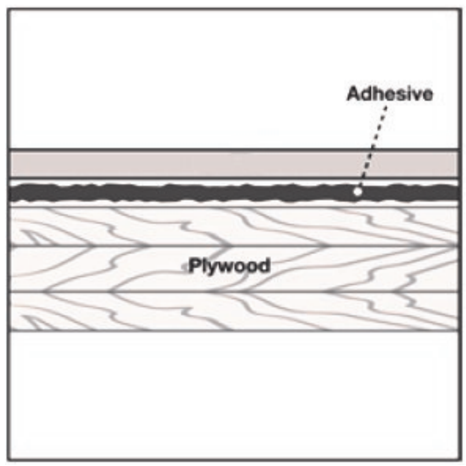

Figure 2a

Generally, HDPE is difficult to adhere to itself or other substrates due to the low surface energy. Two part epoxy and two part acrylic systems have proven effective. Suggested adhesives are shown in the table below. Lap shear strength values of greater than 1,000 psi have been achieved. HDPE has been successfully bonded to itself, wood, aluminum, fiberglass and Gelcoat.

Adhesive Names	Manufacturer
DP 8005	3M Adhesives
DP 8010	3M Adhesives
B45TH	Reltek LLC

NOTE!	Use caution during heat-cycles. Insufficient bonding may occur.

Screwing, Nailing, Stapling

Any type of screw or nail can be used to fasten HDPE material: pre-drilling is typically unnecessary. Power nailers and screw driving equipment are suggested. Inserting the screw or nail in an elongated slot or an oversized hole is recommended so that the material can expand or contract if fluctuations in temperature occur. (Figure 2b).

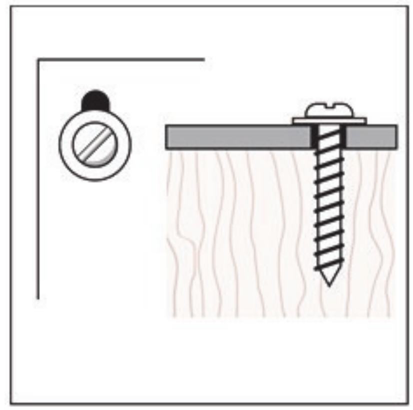

Figure 2b

For best results, use oversized washers or grommets in combination with screws. A course thread deck screw yields good holding power. Vycom has had its HDPE material tested in accordance to ASTM 1761 by an outside laboratory.

Threaded inserts provide strong, usable threads in HDPE. Inserts can be pressed, or placed into HDPE material, and expand when the screw is installed.

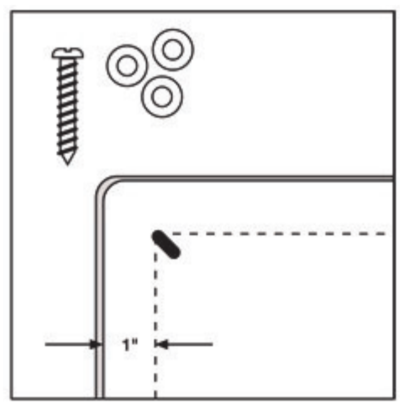

Figure 2c

In small panels under 18” inches or in temperature-controlled environments, allowing for expansion and contraction is not mandatory. Mechanical failures in heating or cooling systems and other unexpected factors can, however, affect temperatures radically and may cause unanticipated expansion or contractions.

Nailing is suggested for small, thin panels of HDPE material. To use larger nails and screws, holes should be placed at least one inch inward from any edges and predrilled (Figure 2c).

NOTE!	Screws should be checked periodically and retightened as necessary. Nails should be checked periodically and replaced, as necessary, due to ‘pop’ after settling.

3

HDPE can easily be shaped using conventional methods, such as heat bending, pressure forming, and vacuum forming. HDPE heats and cools very quickly, which creates very fast cycle times leading to reduced labor. HDPE can also be joined using hot-gas welding, notch welding, and bend welding.

Heat Bending

HDPE sheet material can be bent by using Calrods, strip heaters, air-circulated ovens, or radiant heaters. Heat guns can also be used on small areas. To ensure best results, a rheostat should be used to control heating of the HDPE so that the surface temperature does not exceed 340°F.

Pressure or Drape Forming

Either male or female molds can be coupled with plug assists or forced air to form parts (Figure 3a). This procedure is recommended for simple shallow forms with low definition. Conventional equipment used for thermoplastics is also ideally suited for HDPE.

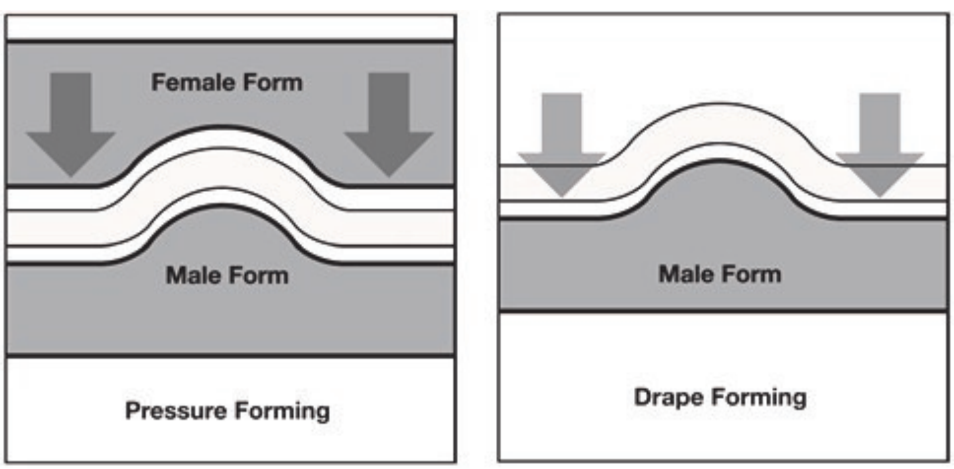

Figure 3a

NOTE!	Heat bending strips should be coated to prevent sticking.

NOTE!	When using radiant heaters, be careful not to overheat the surface.

If the HDPE material is over 5/32" thick, both sides of the sheet should be heated (Figure 3b). When heating from only one side, the top heater should be set at 750°F or below. With two-sided heating, the top heater should be at 750°F and the bottom heater at 650°F. If using an air-circulated oven, the temperature should be between 260°F and 280°F.

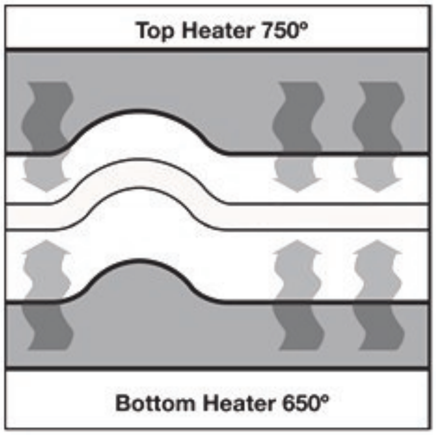

Figure 3b

After the material is heated, place it immediately into the mold. The male mold should have a draft angle of at least 5 degrees. Depending upon the part, the material may need to be larger than the mold to allow for shrinkage or clamping.

Vacuum Forming

Vacuum forming HDPE is similar to pressure forming except that it is generally used when greater part detail and dimensional repeatability are necessary. The forming temperature for HDPE is also higher, generally 300°F to 340°F. Exceeding 340°F is not recommended because it can cause bubbling of the material surface.

Molds for vacuum forming are generally made of wood or plaster for short life short runs and of nonferrous metals for long life long runs. For metals, aluminum is generally the material of choice. Molds should be designed with radii at least two times the material thickness and draft angles of 5° or greater. Vacuum holes should not exceed 1/32" in diameter.

Hot-gas Welding

Hot-gas welding can be performed with a hot air gun and welding rod. The air should be clean and free of all contaminants. If the air is not clean, an inert gas such as nitrogen can be used. The welding temperature and volume of air should be adjustable.

The materials to be welded should be free from dust or oil. For butt welding using the hot gas method, sheets should be chamfered using a table saw, milling machine or router. The angle should be 60° for round bends and 80° for triangle bends with corner welds at right angles (Figure 3d). The chamfer should be at 45°.

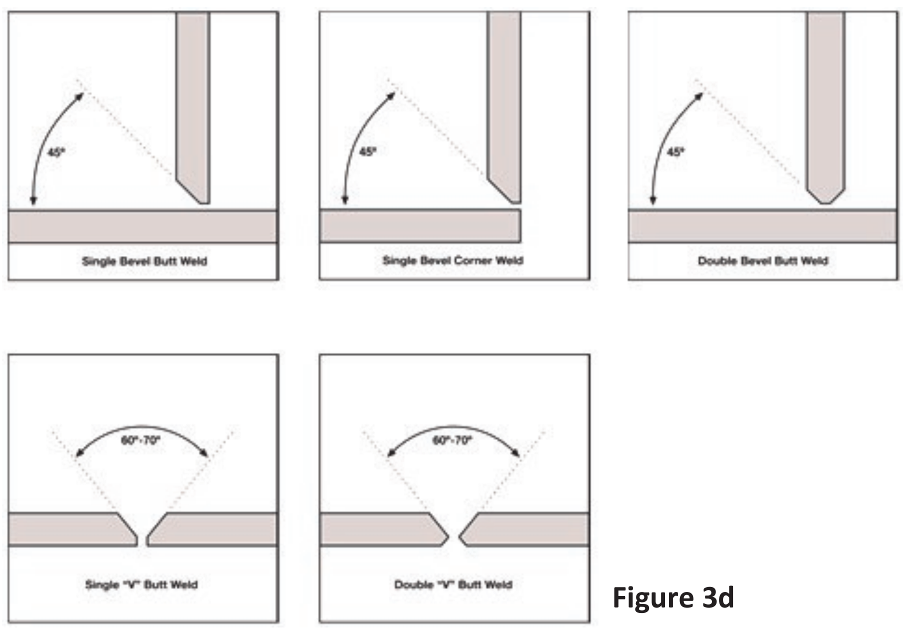

Figure 3d

To weld HDPE material, feed the rod through the gun and apply pressure on the rod as the sheet and rod are heated simultaneously. The temperature of the gas should be at 575°F for a round nozzle, and 590°F with a high speed nozzle, when measured 3/16” inside the tip of the gun. The volume of air should be 50 liters per minute using a flow regulator with welding pressure at approximately 2 to 3-1/2 lbs., depending on the rod diameter. Following these guidelines, welding speeds between 11 and 20 inches per minute are possible.

NOTE!	Skiving off the weld joint for aesthetic purposes will reduce weld strength.

Notch Welding

This welding process uses two heating elements that simultaneously heat up the HDPE material surfaces. Using a heating element, a narrow groove is melted into the sheet material. The groove corresponds to the profile of the cross piece it is being welded to. The process requires good heat distribution. Once the material has softened, the heated cross piece is pressed into the melted groove, so that the two parts weld together.

Bend Welding

This welding process applies a method of heating material with a v-shaped element, when an HDPE sheet is to be bent or folded, normally to an angle of 90° degrees. To bend weld HDPE, material is heated to 390°F (+/- 50°F). Penetration into the material determines the bend angle (ex. 65% - 75% material penetration = 90° bend). Once the heating element has evenly penetrated to the desired percentage, the material can be bent to desired angle. It is common practice to choose a bending angle that is slightly smaller than required. During cooling, the angle widens due to material shrinkage.

Extrusion Welding

Extrusion welding is an alternative method to hot gas welding, commonly used in the manufacture of thick gauge HDPE material where large volume seams are necessary. Extrusion welding can be performed with an extrusion welding gun and welding rod or granular feed, depending on welding gun.

Welding speed is dependent on the flow rate of the extruder, the material thickness, the cross sectional area of the seam, and the size of the welding shoe. The angle of the extruder and pre-heat of the substrate are extremely important.

Expansion / Contraction Worksheet

The following worksheet will help calculate the correct size to cut an HDPE part in order to allow for potential expansion and contraction after installation.

Contraction

A = ____________°F. What is the approximate temperature at the time of fabrication

B = ____________°F. What is the lowest temperature your part will experience in the place of services?

Subtract B from A

This gives you the temperature difference for shrinkage due to cold.

Expansion

A = ____________°F. What is the approximate temperature at the time of fabrication?

B = ____________°F. What is the highest temperature your part will experience in the place of service?

Subtract A from B

This gives you the temperature difference for expansion due to heat

Let's call the difference "D". D = __________°F.

To calculate the total amount of expansion or contraction, multiply the following;

___D____°F x ___L or W____inches x _.00006_= E or C inches

D = temp difference L or W = length or width of part .0006 = coefficient of HDPE expansion

E or C — amount of expansion or contraction

Example: If an HDPE part were being cut in a shop at 70°F and the highest temperature the part will experience is 100°F, the Temperature Difference (D) is 30.

The part is 96 inches, so the expansion is:

30°F x 96" x .0006 = .173" or approximately 3/16"

(temp diff) x (length of part) x (coefficient) = expansion

Thus at 100°F the part will be 96.173"

Conversion Chart: Fractional Inches to Decimal Inches	
1/32"	0.031"
1/16"	0.062"
3/32"	0.094"
1/8"	0.125"
5/32"	0.156"
3/16"	0.188"
7/32"	0.219"
1/4"	0.250"
9/32"	0.281"
5/16"	0.313"
11/32"	0.344"
3/8"	0.375"
13/32"	0.406"
7/16"	0.438"
15/32"	0.469"
1/2"	0.500"
17/32"	0.531"
9/16"	0.563"
19/32"	0.594"
5/8"	0.625"
21/32"	0.656"
11/16"	0.688"
23/32"	0.719"
3/4"	0.750"
25/32"	0.781"
13/16"	0.813"
27/32"	0.844"
7/8"	0.875"
29/32"	0.906"
15/16"	0.938"
31/32"	0.969"
1"	1.00"

VYCOM®
OLEFIN & PVC SHEET

These suggestions and data are based on information we believe to be reliable. They are offered in good faith, but without guarantee, as conditions and methods of use are beyond our control. We recommend that the prospective user determines the suitability of our materials and suggestions before adopting them on a commercial scale.

PLASKOLITE
400 Nationwide Blvd, Suite 400
Columbus, OH 43215
800.848.9124 • Fax: 877.538.0754
plaskolist@plaskolite.com
www.plaskolite.com

FAB057