Fabrication Guide

Fabrication Tips & Techniques

- Optix® Acrylic Sheet
- Duraplex® Impact-Modified Acrylic Sheet
- Roll Stock Sign Grade Acrylic Sheet
- Outdoor Signage

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OPTIX®

DURAPLEX®

PLASKOLITE
MATERIAL
EXCELLENCE

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PLASKOLITE FABRICATION GUIDE

INTRODUCTION

PLASKOLITE is a leading manufacturer of acrylic sheet, acrylic resin, polystyrene sheet and acrylic mirror sheet products. 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 our 350,000 sq. ft. manufacturing and distribution headquarters in Columbus Ohio, 240,000 sq. ft. facility in Zanesville, Ohio, and an 80,000 sq. ft. facility in Compton, California, PLASKOLITE delivers flawless quality sheet and resin to 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.

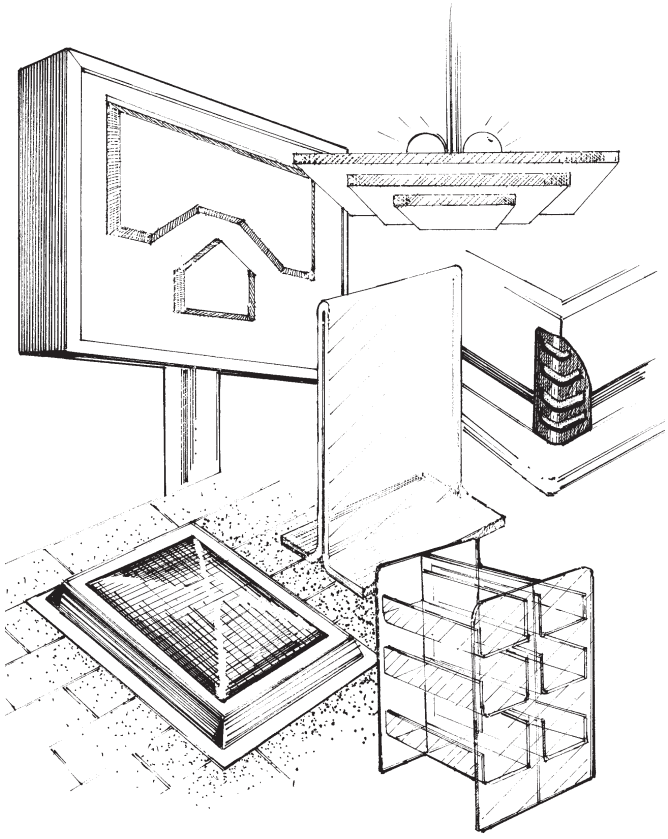
PHYSICAL PROPERTIES

PLASKOLITE acrylic is a continuously processed sheet made through a fully integrated manufacturing process that converts acrylic monomer into acrylic polymer, then into acrylic sheet. It is crystal clear, glossy, durable, weather resistant, and lightweight. Advantages of PLASKOLITE acrylic sheet include; high molecular weight for ease of fabrication, low heat loss for economy, and an attractive clear edge color.

PLASKOLITE produces OPTIX standard grade acrylic and DURAPLEX, which has an impact modifier blended with the acrylic resin. Acrylic sheet is available with a smooth, nonglare or patterned surface, in clear, translucent, and transparent colors. Supplied thicknesses range from .040" to 1.0", and widths up to 105".

The Run-to-Size program allows sheet to be supplied at specific size requirements. This flexibility saves you time, eliminates scrap, improves productivity and reduces wear and tear on your equipment.

PLASKOLITE acrylic sheet is an excellent choice for a variety of industries, including: signage, store fixture, P.O.P. display, skylight, building/window, hobby/craft, lighting, and the automotive aftermarket.



PLASKOLITE's acrylic sheet meets the following:

- ISO 9000 Quality Registration received in 1994
- International Code Council Evaluation Service (ICC-ES) listings as CC2 Plastics (incorporates former ICBO, SBCCI, BOCA and NES certifications)
- ANSI Z97.1 Safety Glazing Requirements
- ANSI Z26.1 (AS-6) Motor Vehicle Safety Standard
- Underwrites Laboratories (UL) listings as UL 94HB and UL746 Compliant
- Miami-Dade County Product Notice of Acceptance-Plastics
- 10-year limited warranty on all clear acrylic sheets
- ASTM D-4802 B-1 Plastics

OPTIX FEATURES

SCRATCH RESISTANCE

OPTIX acrylic sheet is one of the most durable thermoplastic materials for resisting scratches. It is also offered with an abrasion resistant coating, on one or two sides, to protect from excessive scratching.

TEMPERATURE RESISTANCE

OPTIX acrylic sheet can be used continuously in a temperature range of 170-190°F. OPTIX acrylic sheet begins to soften between 210-220°F and starts to melt between 300-315°F. OPTIX acrylic sheet can withstand temperatures down to -20°F without noticeable changes in properties.

LOW HEAT LOSS

Compared to a glass panel, OPTIX acrylic sheet reduces heat transfer and solar heat gain through the sheet. The R value is .86, which describes the degree of insulation provided by acrylic.

IMPACT RESISTANCE

OPTIX acrylic sheet is between 2-10 times stronger than double strength glass. Half the weight of glass, and shatter resistant, acrylic sheet is easy to transport.

EDGE COLOR

OPTIX acrylic sheet offers crystal clear edge color, and excellent optical properties.

LIGHT TRANSMISSION

OPTIX acrylic sheet has a light transmission of 92% and a haze of 2% or less.

WEATHER RESISTANCE

OPTIX acrylic sheet is recommended for both indoor and outdoor use. It is able to withstand prolonged exposure to the sun and the elements.

ULTRA VIOLET FILTERING

OPTIX acrylic sheet filters out between 80-90% of the UV light within the damaging wavelength area of 250-400 nanometers (See Fig. 1).

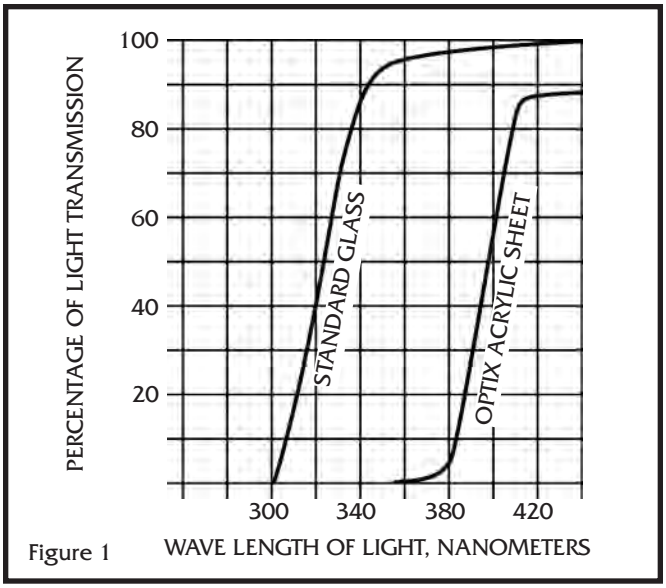


Figure 1

DURAPLEX FEATURES

In addition to the features of OPTIX acrylic sheet, DURAPLEX acrylic sheet can offer the following:

IMPACT STRENGTH

50% medium impact modified acrylic sheet is 10-15 times stronger than double strength glass, and 20-30 times stronger than polished wire glass or other glasses.

100% high impact modified acrylic sheet is 20-30 times stronger than double strength glass, and 40-50 times stronger than polished wire glass or other glasses.

Custom blends are available to meet specific impact requirements.

DURABILITY

DURAPLEX acrylic sheet is great for damage-prone uses, and rough handling.

WEATHERABILITY

DURAPLEX acrylic sheet is an economical alternative to polycarbonate. It offers significantly more weatherability than standard PETG or polycarbonate.

FORMING BENEFITS

DURAPLEX offers a wide operating window of forming temperatures (270-375°F). DURAPLEX is easy to form, with short heating cycles. Excellent part definition, no required predrying, low orientation, and low shrinkage are all benefits of forming PLASKOLITE acrylic sheet.

OPTIX® ACRYLIC SHEET PROPERTIES

Physical Properties	ASTM Test Method	Units	Values
Specific Gravity	D-792		1.19
Optical Refractive Index	D-542		1.49
Light Transmittance Total Haze	D-1003	 % %	 92 2
Sound Transmission	E 90 E 413	db	27
Water Absorption	D-570	% By Weight	0.40
Shrinkage	D-702	% Shrinkage	<5%

Mechanical			
Tensile Strength - Max. Tensile Elongation - Max. Tensile Modulus of Elasticity	D-638	psi % psi	11,030 5.8 490,000
Flexural Strength - Max. Flexural Modulus of Elasticity	D-790	psi psi	17,000 490,000
Izod Impact Strength - Molded Notch Izod Impact Strength - Milled Notch	D-256	ft-lb/in Notch ft-lb/in Notch	0.4 0.28
Tensile Impact Strength	D-1822	ft-lb/in^2	20
Abrasion Resistance Change in Haze 0 cycles 10 cycles 50 cycles 200 cycles	D-1044	 Haze, % Haze, % Haze, % Haze, %	 0 11.2 24.0 24.9
Rockwell Hardness	D-785		M-95

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 determine the suitability of our materials and suggestions before adopting them on a commercial scale.

Thermal	ASTM Test Method	Units	Values
Maximum Recommended Continuous Service Temperature		°F	170-190
Softening Temperature		°F	210-220
Melting Temperature		°F	300-315
Deflection Temperature 264 psi 66 psi	D-648	 °F °F	 203 207
Coefficient of Thermal Expansion -30 to 30°C	D-696	in/(in-°F) x10^{-5}	 3.0
Thermal Conductivity	C-177	BTU-ft/ (hr-ft^2-°F)	0.075
Flammability (Burning Rate)	D-635	in/minute	1.019
Smoke Density Rating	D-2843	%	3.4
Self-Ignition Temperature	D-1929	°F	833
Flame Spread Index Smoke Developed Index	E-84		115 550

Chemical			
Resistance to Stress - Critical Crazing Stress to: Isopropyl Alcohol Lacquer Thinner Toluene Solvesso 100	ARTC modification of MIL-P-6997	 psi psi psi psi	 900 500 1,300 1,600

DURAPLEX® ACRYLIC SHEET PROPERTIES

Impact Modified Acrylic Sheet

PROPERTY	ASTM	UNITS	OPTIX®	DURAPLEX® 30% I	DURAPLEX® 50% I	DURAPLEX® 70% I	DURAPLEX® 100% I
Optical							
Light Transmittance	D-1003	%	92	92	92	90	90
Percent Haze	D-1003	%	2	2	2	<3	<3
Mechanical							
Izod Impact Strength	D-256	ft.lbs./in.	0.4	0.6	0.7	0.9	1.1
Tensile Modulus of Elasticity	D-638	PSI	490,000	376,000	340,000	304,000	250,000
Tensile Strength @ Yield	D-638	PSI	11,030	9,000	8,000	7,100	5,600
Flexural Strength @ Yield	D-790	PSI	17,000	13,690	12,000	10,610	8,300
Rockwell Hardness Method A	D-785		95	78	68	59	46
Thermal							
Deflection Temperature (264psi)	D-648	°F	203	198	194	190	185
Coefficient of Thermal Expansion	D-696	in./(in.-°F)	3.0×10^{-5}	3.5×10^{-5}	4×10^{-5}	4.5×10^{-5}	5×10^{-5}
Self Ignition Temperature	D-1929	°F	833	>850	>850	>850	>850
Burning Rate	D-635	in./min.	1.019	0.85	1.25	1.53	1.97
Smoke Density Rating	D-2843	%	3.4	5.20	8.50	11.5	16.5
Processing							
Density Specific Gravity	D-792		1.19	1.18	1.17	1.16	1.15
Moisture Water Absorption	D-570	% wt. gain	0.4	0.3	0.3	0.3	0.3
Dimensional Molding Shrinkage	D-955	mils./in.	2 -6	3 -6	3 -6	3 -6	3 -6

These values are not intended for specification.

Duraplex/Polycarbonate Comparison

Feature	Duraplex	Polycarbonate
Weatherability	Excellent weatherability with no impact reduction	Yellows when exposed to sunlight, lessens impact strength after exposure
Forming	Better melt strength	Low melt strength
Forming Temperature	Wide range (275°F–375°F)	Distinct forming temperature
Optical Clarity	Very clear	Less clear, hazy, shows distortion
Cost	40% less than polycarbonate	Expensive

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CARE

SAFETY CONCERNS

Acrylic sheet is a combustible thermoplastic, it will ignite and burn if placed in open flame or in contact with any other source of ignition. When storing or working with acrylic sheet, please be aware of the thermoplastic properties and consider fire precautions.

STORAGE

PLASKOLITE acrylic sheet is best stored horizontally, on the supplied flat bulk skids, in a well ventilated, consistent temperature area. Avoid storing acrylic sheet where extreme temperature variations occur, and areas above 100°F. Extreme temperature fluctuations can reform flat sheet as it can expand or contract.

A-frames or special racks can be used to store sheet vertically. Construct the racks allowing the acrylic to lean approximately 10°.

HANDLING

PLASKOLITE acrylic sheet is covered with a polyethylene film or paper masking for protection during storage and fabrication. Avoid sliding sheets across work surface debris. Chips and dirt can penetrate the masking, scratching the sheet.

MASKING REMOVAL

When removing the film and/or paper masking from the acrylic, it is best to start at a corner and peel away from the sheet. If removal is difficult, combine 50% rubbing alcohol with water in a squirt bottle; begin spraying at the edges as you pull away from the sheet.

CLEANING

Clean PLASKOLITE acrylic sheet with a mild soap solution, or a commercially available plastic cleaner, such as PLASKOLITE PLASTIC CLEANER, and a lint free cloth. To remove grease, oil, or tar deposits, use hexane or kerosene, followed by a soap solution. Avoid cleaners containing ammonia or alcohol.

NEUTRALIZING STATIC ELECTRICITY

PLASKOLITE acrylic sheet can be neutralized with an anti-static cleaner such as PLASKOLITE PLASTIC CLEANER, or ionizing air guns, and bars.

CUTTING/MACHINING

SCRIBING & BREAKING

For PLASKOLITE acrylic sheet up to 1/4" thick, score repeatedly along a straight edge with a plastic cutting tool, or Fletcher Terry Knife. Score to penetrate 1/3 through the sheet. Align the score with the edge of the table and apply gentle pressure to break the sheet along the score line (See Fig. 2).

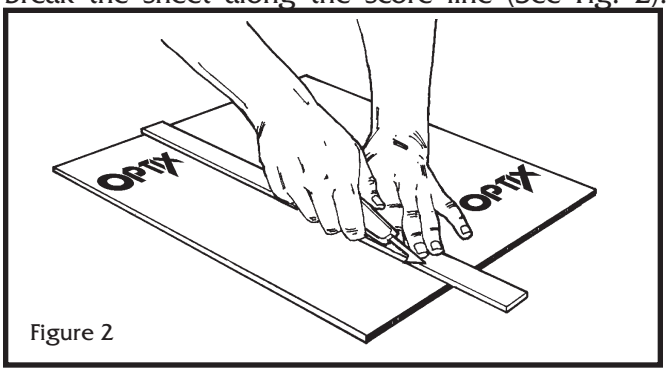

Figure 2

CUTTING

PLASKOLITE acrylic sheet can be cut with a variety of equipment. The selection of blades is critical with regards to the quality of the edge finish.

Table, and Panel saws are the best options for high volume straight cuts. Material can be stacked to cut several sheets at one time. When cutting, the saw blade should protrude through the sheet approximately 1/4" (See Fig. 3). Saw blades, specifically designed for cutting acrylic sheet, are commercially available.

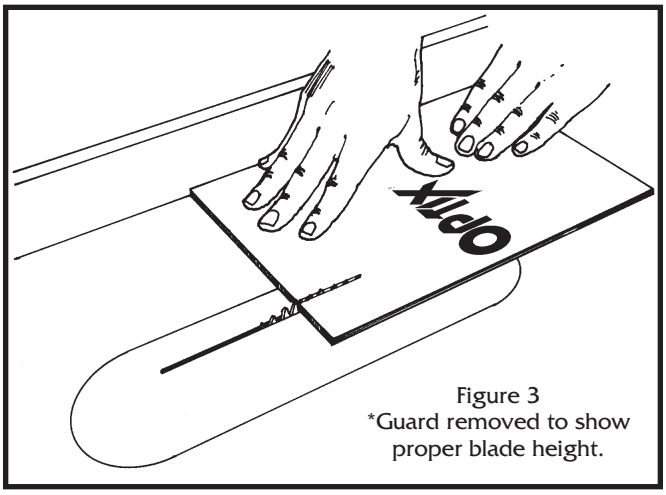

Figure 3
*Guard removed to show proper blade height.

CIRCULAR SAW BLADE SPECIFICATIONS (See Fig. 4):

Rake angle 0 -10°
Clearance angle 10-15°
Blade teeth 80 per 10" blade

Blade Diameter	RPM
6"	6400
8"	5000
10"	4000
12"	3000
14"	2800
16"	2400

Tooth design (See Fig. 5)

Band, scroll, and sabre saws are best for cutting intricate shapes and curves. Again, blade

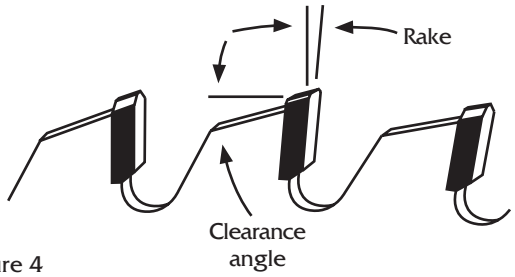

Figure 4

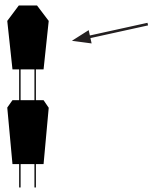

Figure 5

selection and proper feed rate is important to minimize melting or chipping. These saws are excellent for creating templates for vacuum or hand routing, and trimming off excess scrap material.

Routers are one of the most versatile pieces of equipment available to trim PLASKOLITE acrylic sheet. Bit selection is important, and tools specifically designed to rout acrylic are commercially available. Use a downward spiral router bit to prevent masking from fraying. Routers produce a high quality machined edge, ready for finishing, provided the following formulas are followed:

Chip Load = Feed Rate/(RPM X # cutting edges)
Feed Rate = RPM X # cutting edges X chip load
Speed (RPM) = Feed Rate/(# cutting edges X chip load)

Hand routers are best used for low volume work. With a bearing-mounted, flush trim bit, the router can trim around a clamped template.

Pin, table and vacuum routers (hand routers mounted under a table) are more convenient to rout around intricately shaped templates (See Fig. 6).

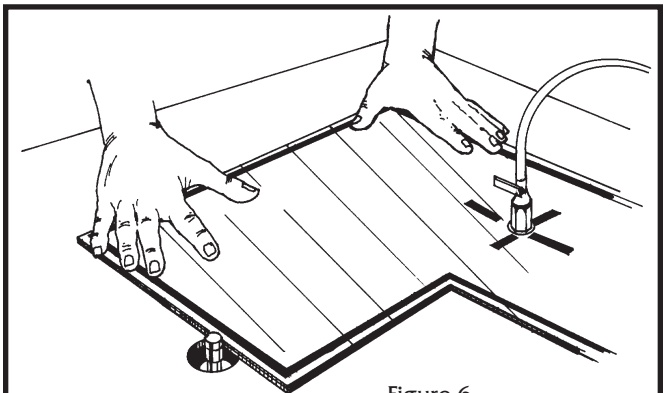
Figure 6
Acrylic sheet vacuumed to a template with a foam rubber gasket between.

Circle routers can cut round parts by securing the acrylic sheet to a turntable, then rotating the sheet around the stationary router.

Computer Numerically Controlled (CNC) routers are used for high volume, intricate, precise acrylic parts. The part is designed on a CAD/CAM system and geometry is programmed directly into the CNC machine. Many of the variables; feed rate, RPM, bit diameter, depth of cut are adjustable for optimum cutting performance.

CNC laser cutters are used to cut virtually any shape part from PLASKOLITE acrylic sheet. This form of cutting produces a clean, polished edge without saw chips. It is well suited for cutting small intricate parts that are difficult to hold down with other cutting processes. Paper masked, or sheet with 3 mil laser cuttable film perform best for this operation.

MACHINING

Many methods are used to produce a desirable edge finish.

Shapers and table routers can machine square, beveled, bull nose, ogee, and other decorative edges (See Fig. 7).

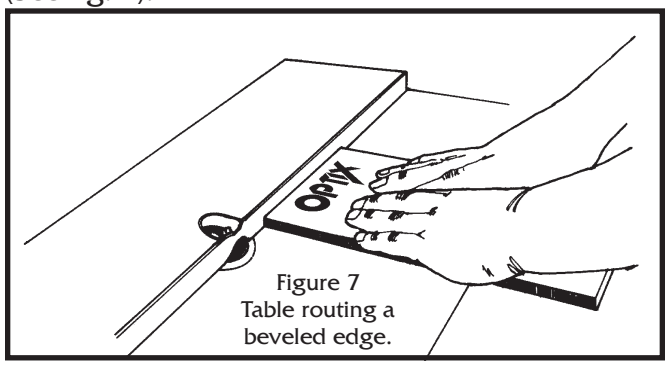
Figure 7
Table routing a beveled edge.

Jointers are used to square and prepare edges for cementing or hand finishing. Multiple sheets can be stacked to increase efficiency (See Fig. 8).

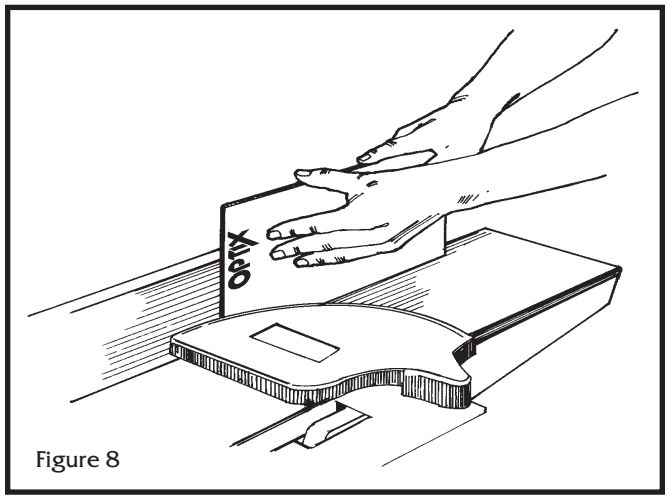
Figure 8

Edge finishing machines with diamond cutting wheels, produce an edge with a polished look, excellent for cementing.

Mills can be used to create precisely machined parts.

DRILLING

Drilling holes is performed best on a drill press with commercially available plastic cutting drill bits. Guidelines for drilling include:

Drill bit Diameter	Speed (RPM)
1/8”	3500
3/16”	2500
1/4”	1800
3/8”	1200
1/2”	900
5/8”	700

The bit should enter the PLASKOLITE acrylic sheet at a slow feed rate, then a steady rate producing two continuous spiral chips, finally exiting through the acrylic slowly, eliminating chipping.

To reduce heat build up, and removal of material, peck feeding may be necessary when drilling thick acrylic sheet.

Place a scrap piece of acrylic or plywood beneath the sheet to be drilled. This will eliminate chipping as the bit passes through.

Standard twist drill bits can be used, provided modifications to the bit are performed. These modifications will allow the bit to scrape rather than cut through the acrylic sheet (See Fig. 9).

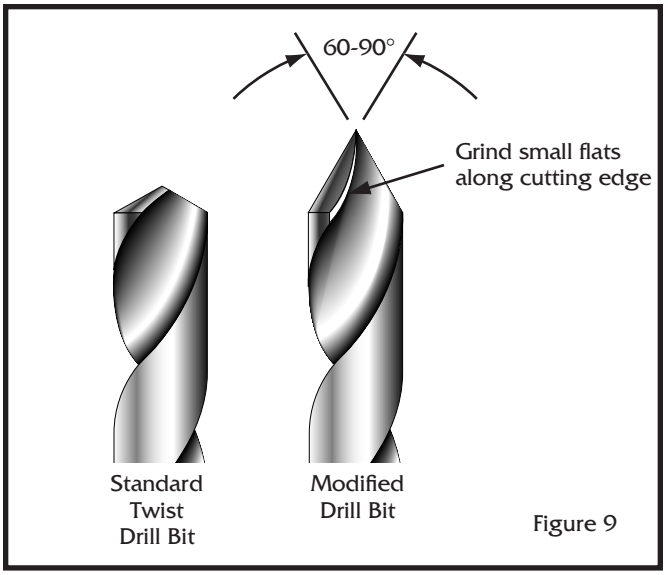

Figure 9

CUTTING/MACHINING TIPS

For optimum cutting and machining quality, certain guidelines should be followed.

Always use sharp tools/blades reserved for cutting acrylic sheet.

Whenever possible use tools/blades specifically designed with proper geometry for cutting acrylic sheet.

Use proper and constant feed rates, and RPMs. To prolong tool/blade life, apply the fastest feed rate that gives a satisfactory edge.

Eliminate vibration of the acrylic sheet through clamping or other hold-down methods.

Align all fences and tables parallel to the cutting device.

Machine PLASKOLITE acrylic sheet with a conventional cut rather than a climb cut.

Machine off as little acrylic as possible. Two passes may be necessary for thicker acrylic; one to rough out the part, then a final skin cut. For jointers and shapers, trim a maximum of 1/32” per pass.

When necessary, direct compressed air or an atomized spray of a water soluble coolant toward the tool/blade.

If all of the above suggestions are followed, heat buildup will be held to a minimum, melting and chipping should not occur, and the edges of the PLASKOLITE acrylic sheet will be ready for finishing or further fabrication.

ANNEALING

After all cutting and machining, internal stresses occur. To reduce the possibility of crazing, (small hairline fissures) during cementing, bending, and forming, annealing is recommended.

Heat PLASKOLITE acrylic sheet for 5 to 6 hours at 130 to 150°F in a forced air oven. Cool the sheet slowly to at least 110°F.

FINISHING

SCRAPING

Scrapers are sharp tool steel devises used to eliminate machining marks and ease sharp edges (See Fig. 10).

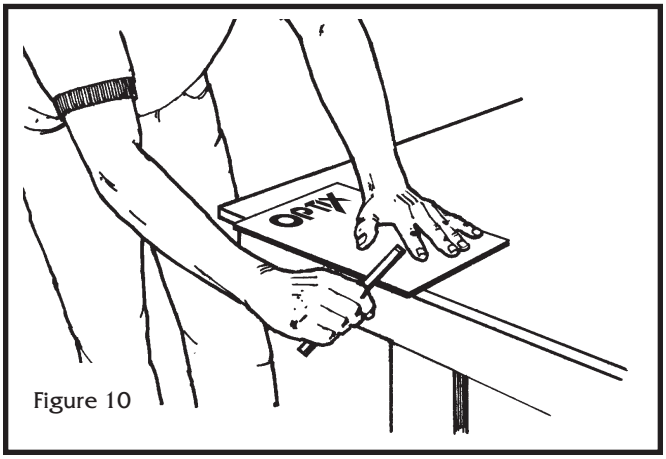
Figure 10

SANDING

All methods of sanding will result in the removal of machining marks, and produce a matte finish. The choice of hand, palm, random orbit, disc, belt, or drum sanding, depends on the quantity, size and shape of the acrylic sheet. Like sanding wood, work from coarse to fine paper. Use light pressure, and keep the part or sander moving to avoid heat build up (See Fig. 11). After sanding, the edge is ready for buffing or flame polishing.

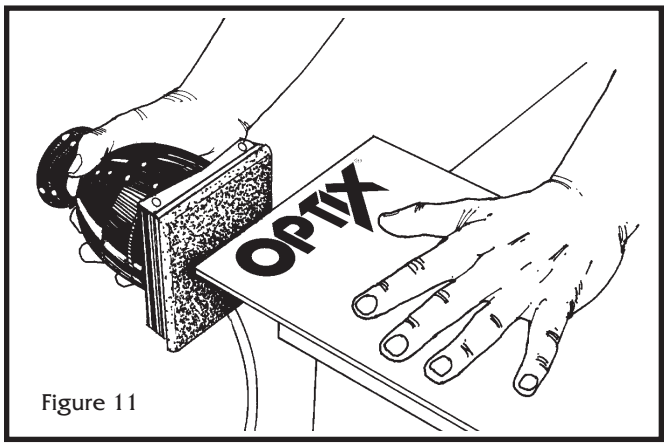

Figure 11

FLAME POLISHING

A hydrogen-oxygen torch, with a #4 or #5 tip, gently melts the sanded or machined edges of PLASKOLITE acrylic sheet, providing a smooth glossy look. Low line pressures create a torch flame that is 2-3" long, bluish, nearly invisible, and narrow enough to prevent overshooting onto the face of the acrylic sheet (See Fig. 12).

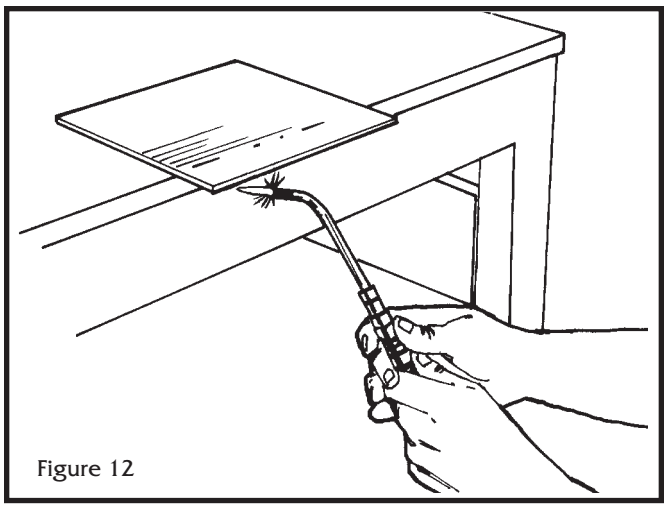
Figure 12

Remove the masking from the acrylic sheet, and guide the torch along the edge at a rate of approximately 3-4" per second. As with other cutting and machining processes, avoid excessive heat build up. Bubbles, stress, and crazing will occur if the flame is moved too slowly. Do not cement a flame polished edge.

BUFFING

A well machined edge is required to polish without additional sanding. Preferably, use stationary machines with polishing wheels dedicated to buffing acrylic. Wheels 8-14" diameter, 2-3" wide, of bleached muslin with bias strips, run cooler than ones fully stitched. With light pressure, keep the PLASKOLITE acrylic sheet moving across the wheel to prevent excess heat build up (See Fig. 13).

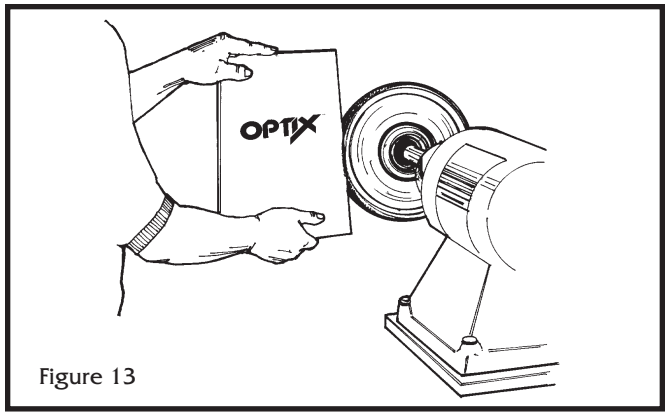

Figure 13

Finish quality depends on the polishing compounds used. A medium cutting compound will result in a good finish in one operation. A high luster finish can be achieved by first applying a fast cutting compound, to remove machining and sanding marks, followed by a fine compound on a finishing wheel.

CEMENTING/FASTENING

Cementing PLASKOLITE acrylic sheet must begin with well machined parts. A square flush fit, without using excessive force, is required to produce a strong, attractive joint and to minimize the chance of "blushing". Cementing should be performed at room temperature in a well ventilated area. A low humidity environment will prevent cloudy joints. Parts to be bonded should not be flame or buff polished.

TYPES OF CEMENTS

Solvent cements - Water thin solvents that soften the acrylic, diffuses and evaporates, allowing the parts to harden together.

Mixed solvent cements - Solvent cement thickened with an acrylic polymer to slow cure times, and fill small voids.

Polymerizable cements - Methyl methacrylate monomer and a catalyst mixed to produce a cement for strong, long lasting museum quality joints.

CAPILLARY CEMENTING

This technique allows solvent cement to flow into the joint and melt the parts together.

Apply cement with a syringe, solvent applicator, or eyedropper. Use small weights, fixtures, and fences to hold the parts in place (See Fig. 14). Initial bonding occurs within 5-10 seconds. A three hour cure time is sufficient to allow further fabrication, and 24-48 hours for maximum bond strength.

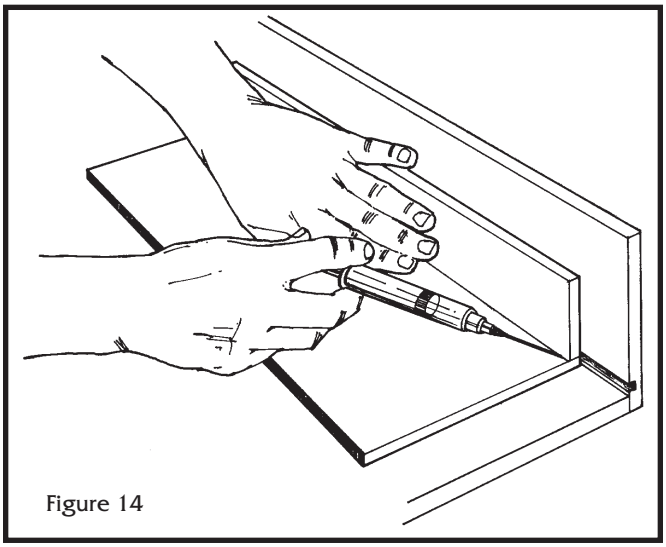

Figure 14

DIP/SOAK CEMENTING

Place small wire brads in a level, shallow tray, pour in solvent to cover the brads. Rest the edge of acrylic on the brads for 1-5 minutes, depending on thickness, allowing the material to soften. Remove the acrylic, drain excess solvent, then quickly and precisely place the edge onto the other part. Hold the parts in place with fixtures or light weights, being careful not to apply pressure. After initial bonding occurs (30 seconds), steady slight pressure can be applied to remove any air bubbles. Allow the joint to cure for 5-20 minutes before moving, and 8-24 hours before conducting further machining or finishing.

ADHERING TO OTHER MATERIALS

Care must be taken when attaching PLASKOLITE acrylic sheet to other substrates. Different coefficients of thermal expansion exist between the two pieces to be fastened, placing large stresses on the bond. To overcome the inherent stress along the joint, keep the dimension of the adhesive area as small as possible, and use elastic cements that remain flexible, such as caulks, polysulfides and rubber based adhesives. Pressure sensitive, double-faced tape, depending on the end use, may also be suitable for joining acrylic to other materials.

MECHANICAL FASTENING

Attaching PLASKOLITE acrylic sheet to itself or to other substrates can be accomplished with screws, nuts and bolts, rivets, or other mechanical fasteners. However, when the acrylic is exposed to fluctuating temperatures, allowances for expansion and contraction must be provided. Drilling oversized holes or slots, using washers and spacers, and not overtightening the fasteners, will allow the acrylic sheet to move (See SHEET SIZE on page14).

ULTRASONIC WELDING

Sonic welding: the use of electrical energy that is converted to mechanical vibration to melt acrylic sheet, can be used to press parts together.

DECORATING

PREPARATION

PLASKOLITE acrylic sheet can be easily decorated using paints produced specifically for acrylic or vinyl. Follow paint manufactures guidelines for thinners, viscosity, methods, and volumes for optimum results. Proper machining, forming, and fabricating techniques should be followed to reduce the chance of crazing. After handling and fabricating, clean the acrylic sheet. Remove dust, masking residue, and static charges prior to painting or vinyl application.

Painting acrylic sheet reduces it's impact resistance. Design considerations should be taken into account to minimize potential breakage.

MASKING

Areas not to be painted can be covered with a liquid maskant, or taped off. If the acrylic sheet is supplied with a paper masking, trim the paper to expose the area to be painted. For excellent results using a liquid maskant, apply a thickness of 10-12 mils wet (3-5 mils dry), allow the maskant to thoroughly dry, and do not expose to UV light (See Fig. 15).

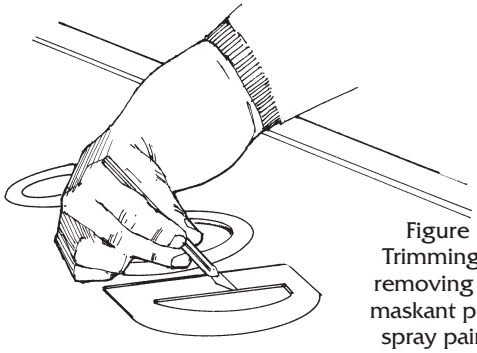

Figure 15
Trimming and removing spray maskant prior to spray painting

SPRAY PAINTING

Use an atomizing spray gun system that will uniformly distribute paint free of water and oil. The use of backlighting will aid in determining the uniformity of paint application (See Fig. 16).

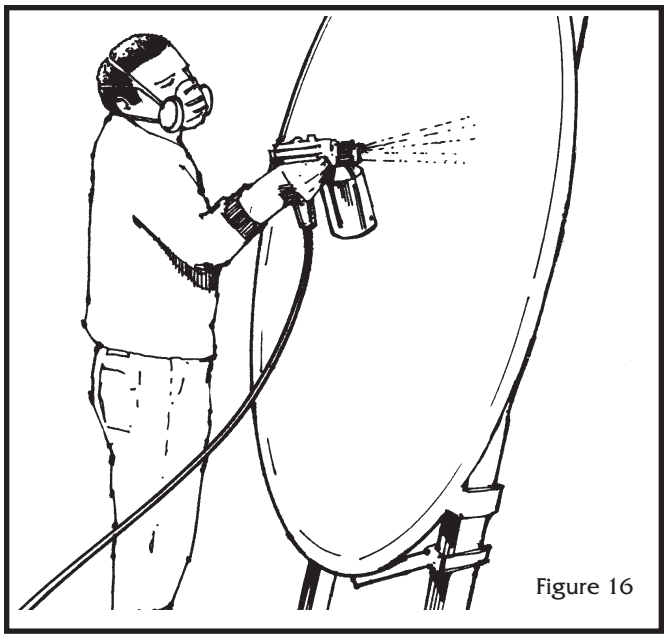

Figure 16

SCREEN PRINTING

For volume production, screen printing is fast and economical. Paint is applied with a squeegee in a uniform motion. Paint passes through a screen and transfers to the acrylic sheet. Using a screen in good condition, with a fine mesh size, in conjunction with paint of proper viscosity, will produce painted parts with good detail.

PAINT REMOVAL

When paint removal is necessary, immediately remove the paint from the acrylic using the paint manufacturer's recommended remover. Paint removers contain organic solvents harmful to acrylic sheet. Time in contact with the acrylic sheet, especially on high stress areas of thermoformed parts, should be minimized to reduce the chances of crazing.

VINYL FILMS

Lettering and intricate designs made with vinyl films, can be adhered to PLASKOLITE acrylic sheet. Vinyl films can be used as a masking during painting operations. Depending on the size of the graphic, apply the film using either the dry or wet method. Choose the proper vinyl film for the application desired (See Fig. 17).

Thermoforming acrylic with vinyl already applied can be accomplished. Certain restrictions, such as heating temperature and time, depth of draw, and thickness of vinyl affect the quality of the end product.

Refer to Vinyl film manufacture's guidelines for more detailed information.

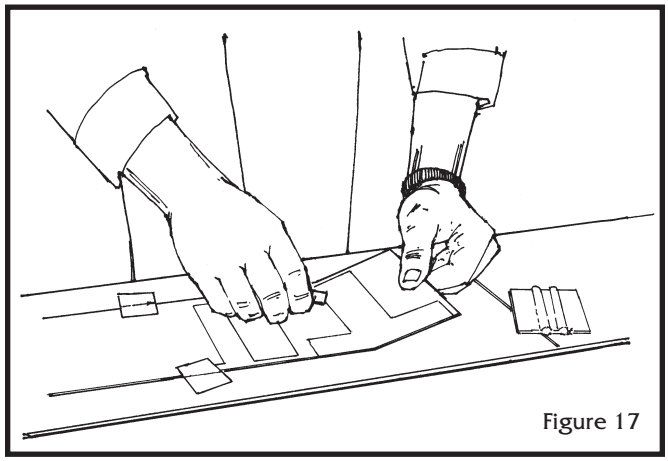

Figure 17

FORMING

COLD FORMING

A bend in PLASKOLITE acrylic sheet can be accomplished without applying heat. A minimum radius of 200 times the thickness of the acrylic is required to avoid stress cracking.

LINE BENDING

Line bending is a method of forming a sharp bend in the acrylic sheet. The radius of the bend can be controlled by adjusting the width of the heated area. Routing a V-groove into the acrylic prior to bending will produce a very sharp bend. Heating elements such as nicrome wire, infrared, rods, or wide strips can be used. Heat the area to be bent to a pliable state then place the sheet in a fixture to cool (See Fig. 18 & 19).

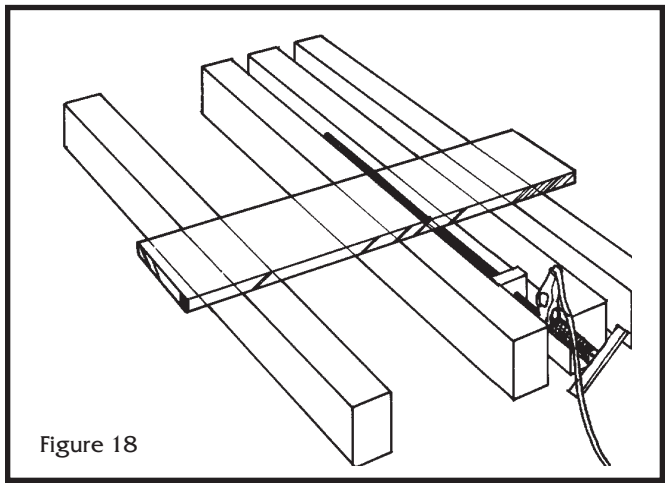

Figure 18

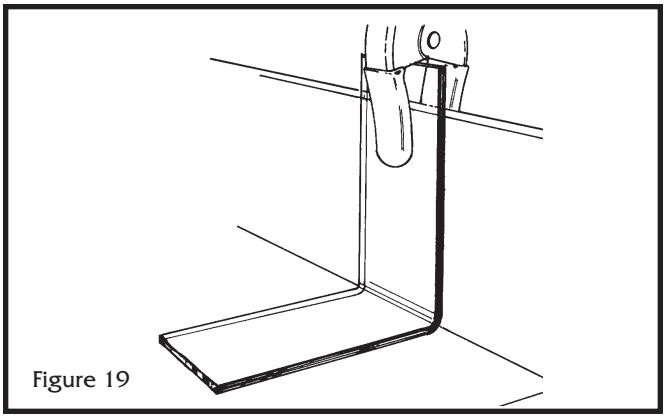

Figure 19

Adjust heating time, element temperature, and distance from the heating element, dependant on acrylic thickness, to eliminate scorching and bubbling, or stress and crazing. Bend the acrylic sheet away from the heat source. Accelerate the cycle time by placing heating elements above and below the acrylic sheet. Visible bowing of the acrylic sheet may occur on bends that are longer than 24". To reduce the amount of warpage, minimize the width of the heated area, heat the entire bend evenly, perpendicular to the sheet's manufacturing direction, and clamp the sheet in place while being heated and cooled.

OVEN HEATING SHEET

An entire sheet of PLASKOLITE acrylic can be heated to forming temperature in an oven. Acrylic sheet can be hung in a vertical oven, or clamped around all four edges and placed in a horizontal oven. Manufacturing orientation of the sheet, shrinkage, and heating uniformity are important factors when determining heating and forming methods.

Sheet temperature is critical. If not heated enough, the sheet will not acquire good part definition, too hot and the acrylic will pick up mark-off from minor imperfections in the mold.

Mold temperature is important for good part definition, and to provide gradual cooling to minimize stress and crazing.

DRAPE FORMING

After reaching forming temperature, the acrylic sheet is draped over a mold covered with flocked rubber or flannel.

FREE BLOWN FORMING

By clamping heated acrylic sheet beneath a forming template, and applying compressed air through an orifice, the sheet can be blown up similar to blowing a bubble. This method can be reversed by drawing the sheet into a chamber using vacuum pressure.

THERMOFORMING

PLASKOLITE acrylic sheet is heated to its forming temperature, placed over a mold, creating an air- tight seal. Vacuum is drawn through the mold, pulling the sheet to it. Once the part takes the shape of the mold, it is slowly cooled, then released.

Typical for signage, Figure 20 shows a method for low volume production. The acrylic sheet is heated while on the mold, vacuum applied. Angle iron presses out any webbing or wrinkles on the flange, and prevents any vacuum loss during cooling. Since the sheet is not clamped in this method, allow for shrinkage in the machine direction.

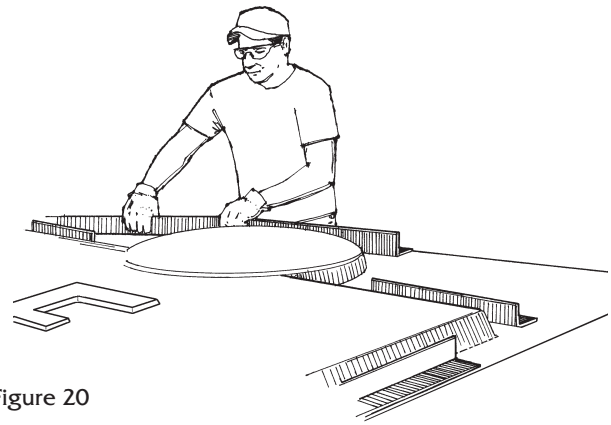

Figure 20

OPTIX THERMOFORMING CONDITIONS

.100" to .375" thickness

PROPERTY	OPTIX & OPTIX SG
Optimal forming temp.	320°F
Forming temp. range	270-350°F
Heating time (two sided infrared)	1-10 min.
Cooling time	.5-4 min.
Optimal mold temp.	180°F
Free shrinkage at forming temp.	
Machine direction	1-3%
Transfer Direction	0%

DURAPLEX IMPACT MODIFIED ACRYLIC THERMOFORMING CONDITIONS

.100" to .375" thickness

PROPERTY	DURAPLEX SG-05	DURAPLEX SG-10
Optimal forming temp.	315°F	310°F
Forming temp. range	270-350°F	270-350°F
Heating time (two sided infrared)	1-10 min.	1-10 min.
Cooling time	.5-4 min.	.5-4 min.
Optimal mold temp.	175°F	170°F
Free shrinkage at forming temp.		
Machine direction	1-3%	1-3%
Transfer Direction	0%	0%

USING PLASKOLITE ACRYLIC FOR OUTDOOR SIGNAGE

INTRODUCTION

Topics related specifically to sign fabrication are presented in this section. Use this portion of the guide, in conjunction with the PLASKOLITE acrylic sheet fabrication guide, to minimize production problems.

Along with flat sheet, PLASKOLITE offers OPTIX SG acrylic sheet, DURAPLEX SG05, and SG10 impact modified sheet in roll form. A wide range of sizes and thicknesses are available.

PLASKOLITE Sign Grade sheet offers many benefits. Features include excellent forming characteristics with detailed vacuum definition, high optical clarity, and superb weatherability. Roll stock sheet features custom widths and lengths to reduce scrap, and no required drying prior to forming.

PLASKOLITE combines a tradition of quality and service with modern production facilities to be the supplier of choice for your sign grade acrylic needs.

ROLL STOCK

STORAGE & HANDLING

It is best to store the reel on a portable A-frame stand. Slide a shaft through the reel ends, then lift the shaft using a forklift or hoist onto the stand. The sheet can be easily unwound for cutting desired lengths, and moved about the facility (See Fig. 21).

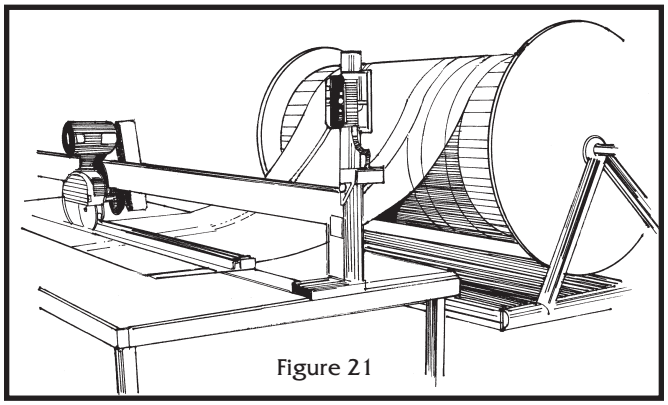

Figure 21

SPOOL DIMENSIONS

For sizes and weights see Figure 22 and the accompanying chart.

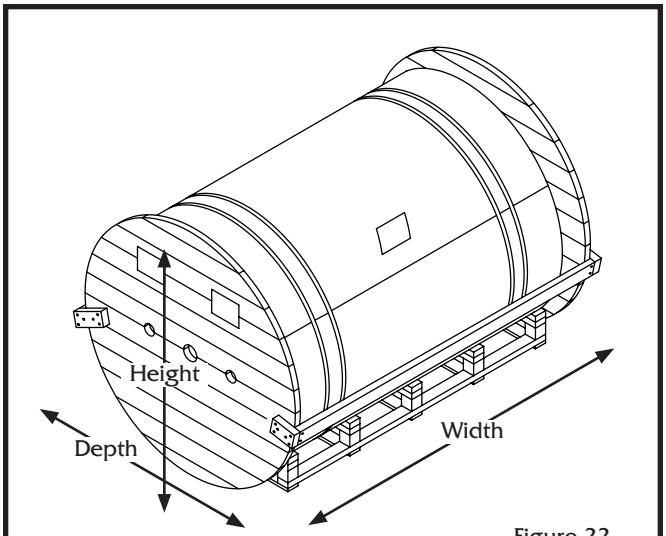

Figure 22

Sheet Width	Dimensions Depth X Width X Height	Approx. Weight (lbs) (.118) 500'	(.150) 400'	(.177) 350'	(.236) 250'
30"	63"D X 40"W X 70"H	1170	1198	1235	1160
39"	63"D X 51"W X 70"H	1540	1514	1575	1480
51"	63"D X 66"W X 70"H	1935	1900	1985	1860
63"	63"D X 76"W X 70"H	2330	2290	2400	2235
75"	63"D X 90"W X 70"H	2475	2775	2825	2710
100"	63"D X 117"W X 70"H	3575	3625	3780	3600

TRANSPORTATION / DISTRIBUTION

Roll stock acrylic can be cut, rerolled and shipped. Care should be taken to cut without chipping. Wind the sheet no tighter than 50" diameter. Protect the entire sheet, especially the edges to minimize the possibility of cracks propagating from impacts to the edges during shipping. Transport the sheet standing on edge.

FORMING & ANNEALING

PLASKOLITE acrylic sheet cut from reels can be thermoformed without annealing. If reeled acrylic is to be used for large, non thermoformed flat sections, annealing is recommended (See page 8). Coiling of the acrylic causes bows, warps, and internal stresses. Without annealing, crazing during secondary sign making operations may occur.

ACRYLIC SELECTION

SHEET THICKNESS

Determining proper sheet thickness is based on the long dimension of the sign and the specified maximum wind load in pounds per square feet (PSF) (See Fig. 23). 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 1.

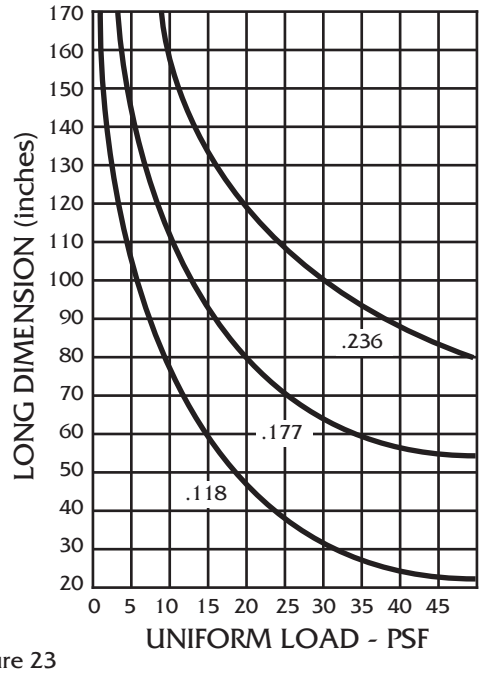

Figure 23

UNIFORM LOAD	APPROXIMATE WIND VELOCITY
20 PSF	75 MPH
30 PSF	90 MPH
40 PSF	100 MPH
50 PSF	130 MPH

Table 1

SHEET SIZE

Contraction and expansion allowances must be taken into consideration when fabricating signs for outdoor applications. PLASKOLITE's sign grade acrylic must be allowed to move freely within a sign's channels to prevent bowing or dislodging. The coefficient of linear expansion is 0.00004-°F, or .000072-°C

Calculate expansion by taking:
Measurement between channels (inches) X (maximum sign temperature* (°F) - room temperature (°F)) X 0.00004.

Calculate contraction by taking:
Measurement between channels (inches) X (room temperature (°F) - minimum temperature (°F)) X 0.00004.

A simple calculation is to allow 1/16" per linear foot for expansion and contraction.

Note: * Maximum sign temperature must remain below acrylic deflection temperature (See physical property tables, pages 4 & 5).

IMPACT RESISTANCE

PLASKOLITE'S sign grade acrylic sheet can be obtained with a choice of impact resistance. From OPTIX SG, a general purpose acrylic, to DURAPLEX SG10 that incorporates the most modifier, PLASKOLITE acrylic sheet can meet the requirements to minimize potential breakage (See physical property tables, pages 4 & 5).

SIGN ASSEMBLY

ATTACHING ACRYLIC TO SIGN CABINETS

Typical sign cabinets use aluminum extrusions to engage the edge of the acrylic sign face (See Fig. 24).

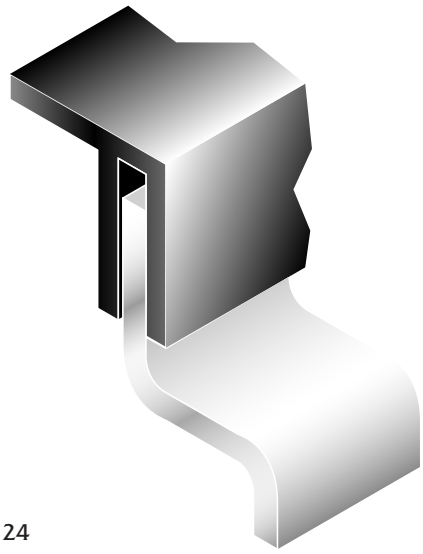

Figure 24

A hanger bar along the top edge of the acrylic should be used to correct any sagging or bowing of the sign face. This technique is commonly used in warmer climates and with large signs where it is necessary to prevent the weight of the sign from resting on the lower portion of the sign frame, reducing the possibility of sign deformation due to high temperature (See Fig. 25).

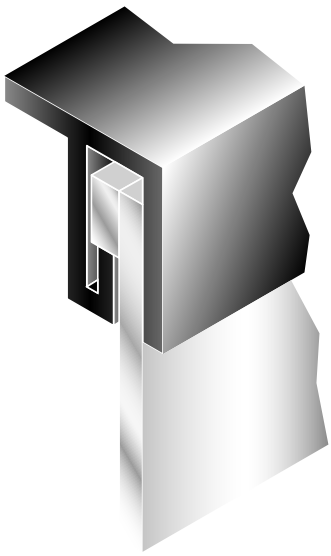

Figure 25

If mechanical fasteners must be used, allow room for expansion and contraction. A method of attachment to prevent acrylic sign faces from binding on the sign cabinet include a spacer, slightly taller than the thickness of the acrylic sheet and the sign cabinet combined, inserted through the oversized hole and slot (See Fig. 26).

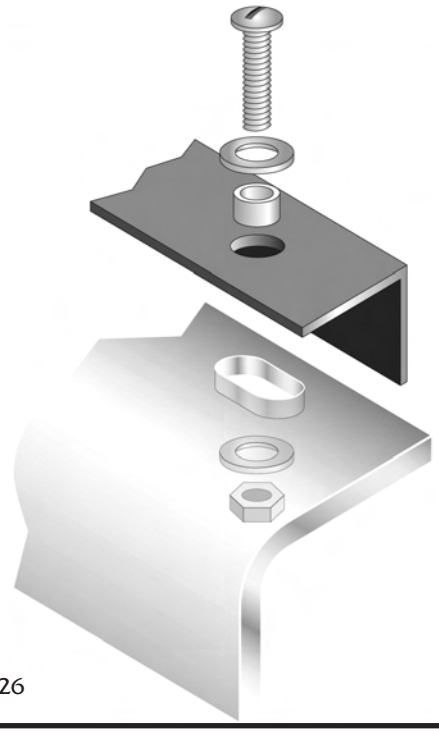

Figure 26

Tie bars are typically used on large signs to prevent the acrylic pan from blowing in, out, or dislodging. They attach the sign face to the cabinet (See Fig. 27). Soft bumpers can also be used to minimize sign faces from flexing inward. Contact between the sign face and the bumper can cause friction, thereby damaging graphics. Both methods work best on signs decorated on the first surface.

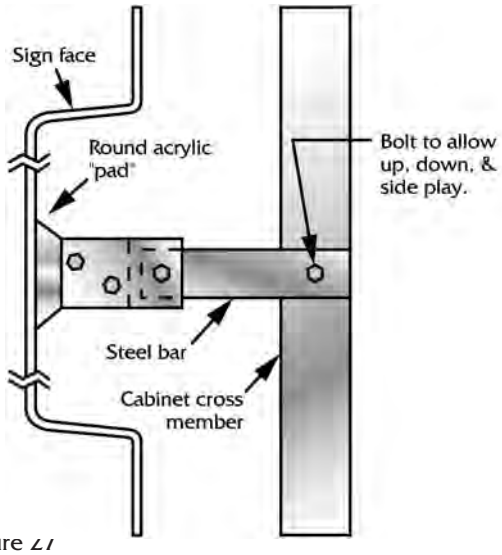

Figure 27

VENTILATION

To prevent sign face distortion caused by heat build up above the acrylic deflection temperature, cabinet ventilation should be incorporated. Consider additional vents when the sign face is decorated with dark paints or vinyl (See Fig. 28).

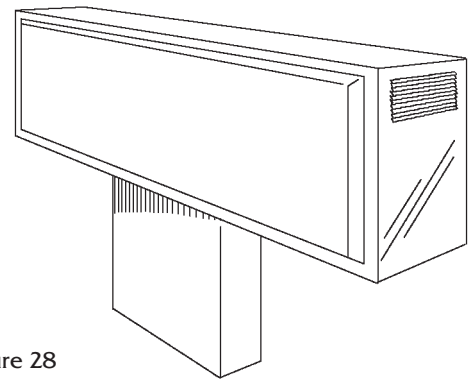

Figure 28

CEMENTING TRIM CAP

Tack trim cap to acrylic with a water thin solvent such as Weld-On #3. Allow to dry, then apply a continuous bead of thickened polymerized cement such as Weld-On #16 (See Fig. 29).

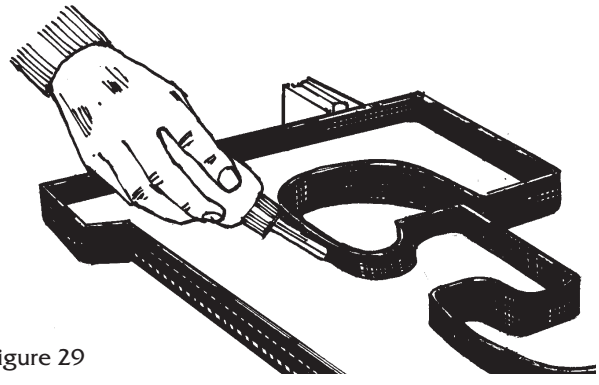

Figure 29

TROUBLE SHOOTING GUIDES

SAWING

DEFECT	CAUSES	SOLUTION
Chipping on edge of sheet	Feed rate is too fast	Slow the feed rate
	Teeth on blade are bent	Check condition of blade so teeth are correctly positioned
	Vibration of stacked sheets	Clamp sheets together tightly
Melting of acrylic	Dull blade	Sharpen blade
	Feed rate is too slow	Increase feed rate
	Incorrect blade angle	Blade angle should be parallel to direction of travel
	Stopping of sheet while sawing	Material needs to move evenly through saw

CEMENTING

DEFECT	CAUSES	SOLUTION
Crazing in machined edge of cemented joint	Stress due to machining	Make sure the tool is sharp, check speed of tool, anneal parts before cementing to reduce pressure
	Edge polishing	Do not polish prior to cementing
	Chemical attack by cement	Change type of cement
Cloudy joints	Excessive moisture	Use slower evaporating solvent Reduce environment humidity
Poor joint strength	Bubbles	Improve surface contact between parts
	Dry spots	Use slower evaporative solvent
	Extra solvent squeezing from joint	Reduce clamping pressure
	Solvent action reduced because of low ambient temperature	Warm solvent, increase room temperature

MASKANTS

DEFECT	CAUSES	SOLUTION
Weak and brittle maskant	Air bubbles in film	Dilute slightly
	Film not thoroughly dry	Wait recommended drying time
	Maskant film too thin	Increase film thickness to 3-5 mils (10-12 mils wet)
Excessive adhesion	Maskant film too thin	Increase film thickness to 3-5 mils (10-12 mils wet)
	Coating exposed to UV	Do not store sprayed acrylic outdoors

SPRAY PAINTING

DEFECT	CAUSES	SOLUTION
Poor adhesion	Incorrect paint	Use paints recommended for use with acrylic sheet
	Dirt or residue on sheet	Clean surface before painting
Blotches of paint	Static electricity	Neutralize charges with ionizing gun Wipe with damp cloth

SCREEN PRINTING

DEFECT	CAUSES	SOLUTION
Poor detail	Screen mesh too coarse	Use a finer mesh
	Paint too thin	Reduce thinner additive
	Worn screen	Replace screen
Paint drying on screen	Hot, dry weather	Add retardant to slow paint drying
	Large lapse of time between screening	Flood screen between passes
Crazing	Stress from fabrication	Review fabrication methods
	Flame polishing	Flame polish as last step

THERMOFORMING

DEFECT	CAUSES	SOLUTION
Bubbles	Overheating	Lower temperature, shorten the heating cycle, increase the distance between heater and sheet.
	Moisture	Pre-dry material before forming, keep masking on sheet until formed.
	Uneven heating	Attach baffles, circulate heated air
Bumps in formed parts	Entrapped air between sheet and form, mold temperature too cold	Change venting system, increase mold temperature or preheat mold
	Sheet too hot, leaving mark-off from the mold	Lower temperature, shorten the heating cycle
Crazing in formed parts	Plasticizer in gasket on finished part	Change material in gasket Flexible vinyl gasket is not recommended
	Chemical put on formed part to clean or polish	Use mild soap and water, isopropyl alcohol, or recommended cleaner
	Stress Concentration	Round or bevel the mold corners to a 45° angel

CHEMICAL RESISTANCE of PLASKOLITE ACRYLIC SHEET

NO ATTACK

Alum, Ammonium
Alum, Potassium
Aluminum Fluoride
Aluminum Sulfate
Ammonia Gas
Ammonium Carbonate
Ammonium Chloride
Ammonium Hydroxide
Ammonium Phosphate
Ammonium Sulfate
Antimony Trichloride
Barium Chloride
Barium Hydroxide
Barium Sulfide
Battery Acid (10%)
Benzoic Acid
Boric Acid
Calcium Hypochloride
Carbonic Acid
Citric Acid
Copper Chloride
Copper Sulfate
Detergent Solution
Diesel Oil
Diethylene Glycol
Ethylene Glycol
Fatty Acids
Ferrous Chloride
Ferrous Sulfate
Magnesium Sulfate
Mercuric Chloride
Formaldehyde
Glycerine
Hydrochloric Acid
Hydrogen Sulfide
Kerosene
Lubricating Oil
Nickel Chloride
Nickel Sulfate
Soap Solution
Sodium Carbonate
Sodium Chloride
Sodium Hydroxide
Sulfuric Acid (10%)
Turpentine
Water (Distilled)

ATTACK

Acetaldehyde
Acetic Acid
Acetic Anhydride
Acetone
Alcohol, Amyl
Alcohol, Butyl
Alcohol, Ethyl
Alcohol, Methyl
Alcohol, Propyl
Ammonia
Amyl Acetate
Aniline
Battery Acid (Conc.)
Benzaldehyde
Benzene
Butyl Acetate
Butyric Acid
Carbon Tetrachloride
Chloroacetic Acid
Chlorosulfonic Acid
Chromic Acid
Dimethyl Ether
Dimethyl Formamide
Ethyl Acetate
Ethyl Alcohol
Ethyl Chloride
Ethylene Dichloride
Ethyl Ether
Formic Acid
Gasoline
Hydrofluoric Acid
Hydrogen Peroxide
Isopropyl Alcohol
Latic Acid
Methyl Ethyl Ketone
Nitric Acid (Conc.)
Sulfuric Acid (Conc.)
Toluene
Xylene

SUGGESTED VENDORS

SAW BLADES

FS Tool Corp.
800-387-9723
P.O. Box 510
210 S. 8th St.
Lewiston, NY 14092-0510

General Saw Corp.
800-772-3691
20 Wood Ave.
Secaucus, NJ 07094

Forrest Mfg. Co. Inc.
800-733-7111
457 River Road
Clifton, NJ 07014

ROUTER BITS

Onsrud Cutter
800-234-1560
800 Liberty Drive
Libertyville, IL 60048

Amana Tool Corp.
516-752-1300
120 Carolyn Blvd.
Farmingdale, NY 11735

Saber Diamond Tools Inc.
614-876-0770
4324 Reynolds Drive
Hilliard, OH 43026

BUFFING SUPPLIES

JacksonLea
800-438-6880
P.O. Box 699
Hwy 70 East
Conover, NC 28613

DRILL BITS

Onsrud Cutter
800-234-1560
800 Liberty Drive
Libertyville, IL 60048

CEMENTS

IPS Corp.
800-421-2677
455 West Victoria Street
Compton, CA

Weld-On 3 Quick set, good bond strength, most aggressive. **Avoid use in high stess areas**.
Weld-On 16 Fast drying, high strength.
Weld-On 40 Reactive gluing system. Good for bonding PLASKOLITE acrylic to other materials.

Lord Corp. Chemical Products
800-458-0434
P.O. Box 10038
2000 West Grandview Blvd.
Erie, PA 16514-0038
406/19 Medium set time for acrylic to acrylic.
7542 & *7545* Acrylic to other substrates.
7550 A/C Acrylic to trimcap bonding.

INKS & PAINTS

Spraylat Corp.
914-699-3030
716 South Columbus Ave.
Mount Vernon, NY 10550
(*Lacryl® Series*)
800 Series (Screen printing)
400 Series (Spray painting)
200-T, 201-T, 205-T (Thinners)
206-T (Cleaner)

Akzo Nobel Coatings Inc.
770-662-8464
3669 Old Peachtree Road
Norcross, GA 30071
(*Grip-Flex® Series*)
FR-1 (Screen printing)
FR-2 (Spray painting)
T-2003, T2004, T-2005 (Thinners)
T-4000 (Cleaner)

Nazdar
913-422-1888
8501 Hedge Lane Terrace
Shawnee, KS 66227-3290
3200 Series

THERMOFORMING EQUIPMENT

Plastic-Vac
800-438-4139
214 Dalton Ave.
Charlotte, NC 28225

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DISCLAIMER

This manual is a general guide for working with PLASKOLITE OPTIX® acrylic and DURAPLEX® impact modified acrylic sheet. Because actual results vary with differences in operating conditions, thickness, color, and composition of the acrylic sheet, nothing contained herein can be construde as a warranty that PLASKOLITE's acrylics 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 OPTIX acrylic sheet or DURAPLEX impact modified acrylic sheet should refer those questions to the PLASKOLITE Inside Sales Department at 1-800-848-9124.

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Plaskolite maintains manufacturing and distribution facilities in Columbus, OH; Zanesville, OH; Compton, CA; Riverside, CA; Olive Branch, MS; Monterrey, MX; Grand Saline, TX; and Doesburg, Holland, for fast product delivery and local support of its distributor network.

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*Zanesville, Ohio, USA
Manufacturing and Distribution

Compton, California, USA
Manufacturing

Riverside, California, USA
Distribution

Olive Branch, Mississippi, USA
Manufacturing and Distribution

Monterrey, Mexico
Manufacturing and Distribution

Grand Saline, Texas, USA
Manufacturing and Distribution

Doesburg, Holland
Distribution

***Plaskolite's Quality Management System is certified as being in conformance with the ISO9000/2000 standard.**
Please contact Plaskolite for technical and distribution information.

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