Working With Acrylic

The How to Book for:
- Bending
- Bonding
- Cutting & Sawing
- Shaping
- Polishing
- Turning
Plexiglas*, Lucite*, Acrylite*
and other Acrylic Materials

*Plexiglas reg. trademark of Rohm & Haas Co.;
*Lucite reg. trademark of E.I.DuPont DeNemours & Co. (inc.);
*Acrylite reg. trademark of American Cynamid Co.
## Clear Acrylic Rod & Tube

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INTRODUCTION
General Health and Safety Precautions
Care must be taken whenever fabricating or thermoforming any thermoplastic, including acrylic sheet. The heat of thermoforming, cutting, machining, finishing, annealing, or otherwise processing Acrylic sheet may result in the release of vapors or gases, including methyl methacrylate (MMA) monomer. Additionally, cementing Acrylic sheet introduces other vapors related to the formulation of the adhesives. However, thermoforming Acrylic sheet, in accordance with recommended techniques at recommended temperatures and with adequate ventilation, should not result in harmful concentrations of vapors or gases in the workplace.

Concentration Levels and Ventilation Standards
High concentrations of MMA vapors can cause eye and respiratory irritation, headache and nausea. The OSHA Air Contaminant Standard for MMA places the maximum permissible exposure level at a time weighted average (TWA) of 100 ppm. Rohm and Haas and Craftics recommend a TWA for MMA of 50 ppm.

It is always good practice to provide local exhaust ventilation as close to the point of possible generation of vapors as practical. Suggestions for the design of exhaust ventilation systems are provided in Industrial Ventilation Manual of Recommended Practice, published by the American Conference of Governmental Industrial Hygienists (1982) and American National Standards Institute, Fundamentals Governing the Design and Operation of Local Exhaust Systems, Z9.2-1979.

Special Precautions
Each of the segments in this manual contains a section on any special hazards or precautions related to the process and materials under discussion. Fabricators and other users of Acrylic sheet are advised to read all of these Health and Safety Precautions sections carefully, to become thoroughly familiar with the properties of these materials, and to take all actions recommended for the safe use and processing of the products. Material Safety Data Sheets should be available from the manufacturer for these purposes.

General Fabrication Considerations
Most fabrication and forming techniques for extruded (like Rohm & Haas Plexiglas MC or Optix) sheet are similar to those used for cast sheet (i.e. Rohm & Haas Plexiglas G), although there are some slight differences, which are noted in the appropriate sections. In order to maximize the beneficial features of each of the sheet products, certain fabrication techniques may differ in working with extruded, continuous cast and cast sheet.

ACRYLIC SHEET PROPERTIES
Strength and Stresses
Although the tensile strength of Acrylic is 10,500 PSI, a stress-crazing can occur due to loads of 1,500 PSI. Localized, concentrated stresses should be avoided. For this reason, and also because of thermal expansion, it is advisable to install Acrylic in frames rather than to fasten a large sheet with bolts.

Rigidity
Acrylic sheet is not as rigid as many other building materials. Under load (wind load) a sheet will bow and foreshorten as a result of deflection. Therefore, on large windows the rabbets (moulding recesses) or channels engaging the edges of Acrylic must be of sufficient depth.

Thermal Expansion
Expansion must be considered because all plastics expand and contract at a far greater rate than metals or glass. Here is a good rule of thumb for outdoor applications: Based on a temperature differential of 100 °F. (maximum difference between summer and winter temperatures), a sheet of Acrylic 24” x 48” will expand and contract almost 1/8” in width and
3/16” in length. Therefore, for outdoor glazing, all sheets should be cut almost 1/16” per running foot shorter than the frame size. Keep in mind that sash rabbets must be deep enough to hold the sheet when it contracts during cold weather.

Breakage Resistance
Acrylic is a tough, resilient plastic. When properly fabricated and installed, it has from 6 to 17 times greater resistance to breakage than glass in thicknesses from 1/8” to 1/4”. It can be twisted and will withstand shock and vibration.

However, chipped edges caused by sawing with a coarse or dull blade will make the sheet crack-sensitive under impact. These nicks should be filed down to a chamfered edge. This characteristic of chipped edges applies also to improperly drilled holes which show small cracks around the edge.

Heat Resistance
Acrylic sheets can be used at temperatures from -30°F up to +200°F, depending on the application. It is recommended that temperatures not exceed 180°F for continuous service, or 200°F for short intermittent use. Acrylic should not be exposed to high heat sources such as high wattage incandescent lamps.

Weather Resistance
Acrylic is virtually unaffected by blazing sun, extreme cold, salt water spray, etc. It will not shrink or deteriorate after long years of service. Clear Acrylic will never turn yellow.

Electrical Properties
Acrylic has many desirable electrical properties. It is a good insulator. Its surface resistivity is higher than that of most plastics. Continuous outdoor exposure has little effect on its electrical properties.

Chemical Resistance
Acrylic sheet has excellent resistance to many chemicals including:

- solutions of inorganic alkalis such as ammonia;
- dilute acids such as sulfuric acid;
- aliphatic hydrocarbons such as hexane and VM&P naphtha.

Acrylic is not attacked by most foods, and foods are not affected by it.

It is attacked, in varying degrees, by
- aromatic solvents such as benzene and toluene;
- chlorinated hydrocarbons such as methylene
- chloride and carbon tetrachloride;
- ethyl and methyl alcohols;
- some organic acids such as acetic acid;
- lacquer thinners, esters, ketones and ethers.

Light Transmission
Clear, colorless Acrylic sheet has light transmittance of 92%. It is clearer than glass and will not turn yellow.

Translucent white Acrylic has excellent light-diffusing properties and is the preferred plastic for all types of lighting fixtures and signs. It can be obtained in seven densities ranging in light transmittance from 11% to 67%.

Acrylic is also available in transparent and translucent colors.

Light Weight
Acrylic sheet is less than 50% as heavy as glass, and 43% as heavy as aluminum. One square foot of 1/8” thick Acrylic sheet weighs approximately 3/4 lb.

CUTTING ACRYLIC SHEET
Health and Safety Precautions
Cutting Acrylic sheet may cause localized heating, resulting in the release of methyl methacrylate (MMA) monomer vapor, and may also generate some polymer dust. See Concentration Levels and Ventilation Standards, at left. Any dust produced by the cutting of Acrylic sheet is considered
"nuisance" dust. The current OSHA Air Contaminant Standard for this type of dust places TWA exposure to total dust at 15 mg/m³ and respirable dust at 5 mg/m³. Worker exposure to dust can be controlled with adequate ventilation, vacuum dust removal at the point of generation, or the use of suitable protective breathing devices.

Cutting

Acrylic sheet may be cut by sawing or routing with power equipment saws or by scribing and breaking. Scribing is limited to straight cuts in thin pieces of Acrylic sheet, 0.236 inch or less, and is practical for use by the craftsman who has no power tools when cutting small quantities of sheet material. Sawing and routing may be used for straight and curved cuts on any thickness of material.

The following information is applicable to all grades of Acrylic sheet, except where noted. If possible, use sheet with pressure-sensitive adhesive masking adhered to both surfaces. Keep the masking paper intact during fabrication to protect the surfaces and provide lubrication.

Acrylic sheet is a combustible thermoplastic material. Observe fire precautions appropriate for comparable forms of wood and paper products.

The kind of cutting to be done on Acrylic sheet should determine the type of sawing equipment to be used. Circular blade saws are limited to straight cuts; scroll and saber saws for rough cutting small-radius curves in thin Acrylic sheet and band saws for rough cutting larger-radius curves or for making rough straight cuts in thick Acrylic sheet. Routers and woodworking shapers are used for cutting and trimming the edges of flat and formed parts of any configuration and provide the best overall fabricated edge.

Scribing and Breaking

Straight cuts in 0.236 inch or thinner pieces of Acrylic sheet can be made by scribing with a Craftics Swivel Blade Plasticutter or Replaceable Blade or Heavy Duty Plasticutter. Scribing is effective when the quantity of sheet to be cut is limited, for it requires very little
capital outlay for tools. Neither thick sections nor patterned Acrylic sheet can be cut by this method, however. If the sheet is masked, it should first be scored using the tip of the tool and a metal straight edge as the guide. Then the hook point of the cutting tool is placed at the far edge of the material and drawn the full width while applying firm pressure. This is repeated once for every 0.025 inch to 0.040 inch of sheet thickness. Figure 3A shows this procedure.

The scribed line is then positioned face up over a 3/4 inch diameter wood dowel running the length of the intended break. The sheet is held with one hand and downward pressure applied with the other hand on the short side of the break. The hands should be kept adjacent to one another and successively repositioned about 2 inches behind the break as it progresses along the scribed line. Figure 3B illustrates the procedure for breaking. The practical minimum cutoff width for scribing and breaking is 1-1/2 inches.

Circular Blade Saws

There are several types of circular blade saws suitable for cutting Acrylic sheet. Table saws vary in size from small, light-duty models to large, heavy-production models and are generally used for cutting Acrylic sheet to close dimensions. The size of table saw most commonly used is a medium-duty model with an arbor of 5/8 to 1 inch diameter and powered by a 1.5- to 5-hp motor. Special fixtures are often used to hold the work steady for accurate cutting.

Radial saws and swing saws move while the work is held stationary and are generally used to make angle cuts and cross cuts in narrow pieces of Acrylic sheet. The length of cut of a radial saw is limited to about 24 inches.

Panel saws are of two types. The first has the saw blade and motor mounted above the material to be cut. The work is placed on the table against a fence and the saw is fed through the work. The second type has the saw blade and motor mounted below the material to be cut with a combination saw guard and hold-down bar. The blade extends through the table high enough to cut through the material. This type of panel saw is usually set so that the saw blade must be retracted before the saw guard and hold-down bar can be released. These saws are available with either horizontal or vertical tables. The vertical saws offer advantages in that less floor space is needed; large sheets of Acrylic sheet may be placed on the saw more easily; and there is less danger of scratching unmasked sheets of Acrylic sheet.

Circular saws should have motors with sufficient power. A 10-inch diameter saw should be powered by approximately a 2-hp motor; a 14-inch diameter saw, by approximately a 5-hp motor. Blades are

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**CRAFTICS SWIVEL BLADE PLASTICUTTER**
Hardened steel blade scores and cuts acrylic up to 1/4" thick. Swivel blade folds away safely for storage, yet stays in place when scoring. Simply score material and break along straight line. Stock No. 1106087.

**CRAFTICS REPLACEABLE BLADE PLASTICUTTER**
This knife features a replaceable blade. Will cut acrylic sheets up to 1/4" thick. Simply score material and break along straight line. Stock No. 1106013.

**CRAFTICS REPLACEMENT BLADES**
Package of 3 blades. Stock No. 1106014.

**CRAFTICS HEAVY DUTY PLASTICUTTER**
Larger and heavier blade for easier cutting of acrylic sheet up to 1/4" Stock No. 1106531.
normally driven direct and run at a motor speed of 3,450 rpm. Saws should be equipped with heavy-duty, production-type fences, be well-guarded and have sawdust removal systems. Kick-plate switches and electromagnetic or frictionless electronic motor brakes should be provided for safety purposes.

Programmable horizontal and vertical panel saws with a movable fence can be used to cut Acrylic sheet to size in high-production operations.

Saw blades should be equipped with carbide-tipped teeth of the triple-chip style. This tooth style is also called square and advance. Triple-chip-style teeth are designed so that alternate teeth start and finish the cut. The slight chamfering of the square tooth corners minimizes chipping. Carbide-tipped blades give cuts of superior quality, cut faster, and require fewer blade changes because of dulling. However, such blades must be returned to the factory for resharpening.

For best results with continuous cast sheet, circular saw blades should be the largest diameter possible and contain 60 carbide-tipped teeth with a triple-chip tooth design. Teeth should be shaped with a 5 degree to 10 degree positive rake angle and have sharp cutting edges with adequate clearance.

To obtain the optimum cut from carbide-tipped blades, the saw and stabilizer discs must fit the arbor closely with a clearance of about 0.001 inch, and must run true. Loose bearings, bent arbors, or misaligned or burred stabilizers will vibrate and cause cuts of poor quality and shorten blade life. For maximum service life, carbide-tipped blades used for cutting Acrylic sheet should not be used to cut any dissimilar materials.

To minimize blade wobble, which results in the generation of heat and possible melting of the plastic, the use of a single- or double-mounted, precision-ground, hardened-steel stiffener with a diameter 4 inches less than the saw blade and a blade with additional radial/side tooth clearance is highly recommended. Where the quantity of the Acrylic sheet to be cut does not warrant the purchase of carbide-tipped blades, high-speed steel blades designed to cut Acrylic sheet may be used instead. These blades are made of alloy steel and are tempered to permit filing. The teeth should have a positive rake angle of 0 degrees to 10 degrees and should be of uniform height and shape. When cutting 0.150 inch or thinner sheet, the blade should be hollow ground rather than set. Teeth of uneven height will cause chipping of the Acrylic sheet and will place undue cutting strains on a few teeth. This may cause the saw blade to crack. The saw blades should be machine filed or ground.

For cutting very small quantities of Acrylic sheet, standard hollow ground, fine-tooth blades used for cross cutting wood or ply-tooth
blades may be used.

**Circular Blade Saw Operation**

To minimize both chipping and overheating tendencies, circular saw blades should protrude approximately 1/2 inch more than the thickness of the Acrylic sheet. The work must be held firmly against the fence, which must be parallel to the saw blade.

Several sheets of Acrylic can be cut at one time by stacking one on top of another. Suitably designed holding fixtures must be used when stacks of sheets are to be cut to close tolerances.

When unmasked sheets of Acrylic are cut, it is necessary to take care to avoid scratching the surface of the sheet. Working surfaces should be covered with some soft material such as medium-density felt. The surface should be kept free of dirt and chips.

Sawdust and chips remaining on the surface of the Acrylic sheet after cutting may be removed by blowing with compressed air. Wiping the surface of the sheet with a damp cloth will remove sawdust that clings to the material because of static electricity. The damp cloth will also dissipate the static charge.

When cutting Acrylic sheet on a table saw, a cutting board should be used for cutting stacked/clamped material or making a cut not parallel to another edge (angle cut). Figure 2 shows a suitable cutting board. The Acrylic sheet lies stationary on the board while the board moves across the saw table.

When cutting stacked Acrylic sheet to final dimensions with a panel saw, hold-down clamps should be used when feasible. This procedure will also help reduce chipping. The manual feed rate should be 3 to 4 inches per second (15 to 20 feet per minute) and should be uniform. The saw should be allowed to cut freely while maintaining the rated speed of the motor. Coolants are not required for most sawing operations, although if exceptionally smooth cuts in thick sheet are needed, a fine spray mist of detergent in water or 10 percent soluble oil, compatible with Acrylic sheet, in water can be directed against the saw blade.

For extruded acrylic sheet, circular saws should operate at speeds of approximately 3,450 rpm and the material feed rate should be about 4 inches per second. The saw blade should be set at a height only slightly greater than the thickness of the material being cut, to assure a smooth, chip-free edge on either single or stacked cutting of sheets. Elimination of gumming or welding of the sheets during stack cutting can be reduced by applying compressed air or an approved liquid coolant to the saw blade and material to reduce heat buildup.

Clamp the stack if possible. Make sure that the saw arbor runs true and the blade plate is flat to prevent rubbing.

**Band Saws**

Band saws should be used when curves are cut in flat sheets or when formed parts are rough trimmed. They are also used for making straight cuts in thick pieces of Acrylic sheet. For production work, large saws with a 30-to-36-inch throat are best, although smaller band saws are satisfactory for small work. The blade should run at a speed of 2,300 to 7,500 feet per minute. As a general rule, as the thickness of the Acrylic sheet increases, the number of

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**CRAFTIES NO MELT TRIPLE CHIP CARBIDE SAW BLADES**

The professional's choice for accurate feeds, clean cuts and lower sharpening costs. Blades cut single or multiple stacked sheets where melting or chipping can be a problem.

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teeth per inch on the blade should decrease. See Table 1 for recommendations.

Metal-cutting blades and, in particular, bimetallic blades stay sharp longer than blades designed for cutting wood and are better for use on Acrylic sheet. They are supplied by several manufacturers in 100 ft. coils and can be cut to the proper length and brazed or welded. The weld must be annealed and dressed.

Blade thickness, width, and the number and type of teeth depend on the size of the bandsaw, the thickness of the material to be cut, and the minimum radius to be cut. Band saw blades of 0.250 inch to 0.375 inch width should be used for cutting curves; blades of 0.50 inch to 0.75 inch width should be used for straight ripping or cutting large-radius curves. The diameter of the bandsaw wheels will determine the maximum thickness of the blade. The thickness of the blade increases as the diameter of the wheels increases.

Special band saw blades, called “skip tooth” or “buttress” blades, have been developed for soft materials such as plastics and are available with 2, 3, 4 or 6 teeth per inch. These blades should be used when cutting thicknesses greater than 0.472 inch. These blades are hardened and will retain their sharpness for long periods when used only for cutting Acrylic sheet.

Variable pitch (number of teeth per inch) blades work well in reducing chipping when cutting sheet 0.472 inch thick or less.

Band Saw Operation
The tension on the saw blade should be just enough to prevent slipping on the wheels but not enough to stretch the blade and cause misalignment. The guide rolls or blocks should be set so they just miss the teeth but support the rest of the blade width. They should be set so that their rotation can be stopped with pressure from the thumb and forefinger when the saw is turned by hand. The back-up roll should be adjusted so that it does not turn when the saw is idling, but will provide support while the saw is cutting. When cutting formed sections, it may be necessary to raise the upper guide. When this is done, extra care is necessary to ensure proper alignment. For added safety, the upper guide should be as low as possible (within 1/2 inch of the Acrylic sheet).

The action of the saw carries sawdust from the Acrylic sheet and the masking paper onto the wheels. The dust builds up on the wheels and may cause the blade to run off. Therefore, this accumulation of dust must be removed. Stiff bristle brushes can be placed so that they touch the tires and clean them as they revolve. The brushes should be held with a light spring tension so that they will make contact, yet not cause excessive wear on the tires.

Internal cuts may be made by drilling a hole through the Acrylic sheet and cutting and welding the blade inside the hole. Once the internal cut is completed, the blade must be recut, removed from the hole, and re-welded. This technique may be useful for special jobs but is too time-consuming for production use.

When cutting unmasked Acrylic sheet on a bandsaw, special care must be taken to prevent scratching. The saw table must be kept clean and should be free of nicks or burrs. Kraft paper or cardboard should be placed on the table under the unmasked sheet. Tape or rubber cement can be used to hold the paper and the Acrylic sheet together to ensure that both will move through the saw together. When trimming flanges on formed parts, the flange will slide on the saw table so any scratching will not be objectionable for most applications. For other curved work, a piece of

<table>
<thead>
<tr>
<th>Thickness to be Cut</th>
<th>Blade Width (Front to Back)</th>
<th># Teeth Per Inch</th>
<th>Tooth Style</th>
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</thead>
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<tr>
<td>Up to .118&quot;</td>
<td>3/8&quot;</td>
<td>18</td>
<td>Reg.</td>
</tr>
<tr>
<td>.118&quot; - .472&quot;</td>
<td>1/2&quot;</td>
<td>10-14</td>
<td>Reg.</td>
</tr>
<tr>
<td>.473&quot; - 2&quot;</td>
<td>3/4&quot;</td>
<td>6</td>
<td>Skip or Buttress</td>
</tr>
</tbody>
</table>
wood about 1/2 inch thick by 1.0 inch wide can be run partially through the saw and clamped to the saw table at the ends. The main portion of the acrylic part will be raised slightly above the saw table while the kerf is supported by the wood strip.

For extruded acrylic sheet, band saw blades should be of the edge-hardened metal-cutting-type with raker set or broach-style teeth. Blades should have 10 to 14 teeth per inch. Speeds should be between 2,300 and 5,000 feet per minute. In general, the thicker the stack of material, the slower the blade speed should be to avoid overheating. Blade speed and material feed and thickness should be such that each saw tooth cuts a clean chip. The welded joint of the blade should be smooth and carefully aligned to prevent chipping or cracking of the material during the cutting operation. A band saw cut should not be considered a finished edge and, if not a rough cut, should be further finished by scraping.

**Scroll Saws**

Scroll saws may be used for cutting sharp radii and closed holes in thin pieces of Acrylic sheet, but are less suitable for cutting thick sections or multiple sheets. Because of the short stroke, scroll saw blades do not clear the chips and tend to gum up. When this happens, the plastic softens and welds around the blade. Scroll saws must be used with a light feed and without forcing the work. The teeth should be cleared often. As soon as the blade stops cutting cleanly, it should be backed out, the chips removed, and the sheet cooled. Welding of the plastic behind the blade may be alleviated by using two blades mounted side by side, or by using an air blast to remove chips and cool the Acrylic sheet. A coolant may also be used. Masking material should always be left intact to provide lubrication in addition to protecting the sheet. Blades should be sharp with 10 to 14 teeth to the inch. Hold-downs are necessary to prevent vibration.

**Saber Saws**

Portable saber saws may also be used for making either straight or curved cuts in Acrylic sheet. When using this type saw, however, it is necessary to provide adequate support for the Acrylic sheet, since the vibration caused by the reciprocating action of the saw blade may chip or crack the sheet. Chisel-type saber saws should be adjusted so that the cutting chisel stroke is about 3/16 inch greater than the thickness of the work to be cut. Two thicknesses of corrugated fiberboard should be placed on the working surface under the Acrylic sheet. The stroke of the chisel should clear the upper surface of the sheet by about 1/16 inch and penetrate into the corrugated fiberboard about 1/8 inch, thus driving the plastic chips into the board. Craftics has 2 types of saber saw blades in their saber saw blade pack, one for material up to 1/8” (gold blade) and the other for material thicker than 1/8” (green blade).

**Veneer Saws**

Veneer saws are small circular saws mounted on arbors and powered by high-speed electric or air motors. They are available as stationary or portable models. The saw blades are made in 3-inch and 4-inch diameters with several teeth per inch and have considerable set. They should be driven at 10,000 to 15,000 rpm to give a surface speed of 8,000 to 15,000 feet per minute. Veneer saws cannot be easily guarded and must be used with great care. Carbide-tipped blades should not be used unless designated for high-speed operations.

Portable veneer saws are most often used to trim large formed parts of Acrylic sheet held in trimming fixtures. Stationary veneer saws can be used in woodworking shapers or routers for trimming the flanges of compound formed...
parts when the flange is in one plane. The height of the saw is adjusted to the proper distance above the table and the work is moved past the revolving blade.

**Hole Saws**
A hole saw is a tubular tool with teeth filed on the lower edge of the tube. The teeth have a set to cut a groove wider than the thickness of the tool wall. A shaft is fastened to the top of the tube so that it can be mounted in a drill press to drive the saw. Usually a pilot drill and guide are provided to locate and center the hole saw. Knockout holes are located in the top of the saw to allow removal of the discs. Hole saws are stocked in sizes from 5/16-inch to 4-inch diameters. Large-diameter hole saws may be made by inserting a piece of band saw blade in a groove machined in a steel disc and holding it with set screws. Coarse-tooth saws should be used for cutting Acrylic sheet.

The Acrylic sheet should be cut half-way through, turned over, and the finishing cut made from the other side. When cutting sheet greater than 0.236 inch thick, a detergent/water lubricant and coolant should be used. A sawn-cut hole is typically rough and often melted, requiring a post-finishing operation. Better quality holes can be achieved by machining with a router or circle cutter.

**Scraping Edges of Acrylic Sheet**
After cutting the Acrylic sheet, it is often desirable to scrape the edges. Scraping serves two purposes: it removes any nicks or burrs that may form a notch to weaken the material, and it improves the appearance of the edge by removing cutting marks. Dubbing both edges at the same time may be done by grinding a V-notch into the scraper.

A suitable scraping tool is the Crafties Edge Scraper, which features four functions in one. Not only will it remove saw marks from flat edges, it also bevels thick and thin material, and will radius the edge quickly and evenly.

The Acrylic sheet part should be held firmly in a vise or holding fixture. Scraping can be accomplished by pushing or drawing of the tool, whichever is more comfortable. Firm, steady pressure should be used throughout the scraping operation. Care must be taken to keep the scraped edge square.

**MACHINING ACRYLIC SHEET**

**Health and Safety Precautions**
Machining Acrylic sheet should not result in harmful concentrations of vapors provided that adequate ventilation is employed. To assure this, both general and local exhaust ventilation are recommended. See Concentration Levels and Ventilation Standards, page 2.

Before using any soluble oils or wax sticks as machining aids for Acrylic sheet, review and follow the manufacturers' recommendations for safe use of these products.

Acrylic sheet is a combustible thermoplastic material. Observe fire precautions appropriate for comparable forms of wood and paper products.

**Machining**
The usual rules of good machining practice apply to the machining of Acrylic sheet. An experienced machinist should have no difficulty handling Acrylic sheet as soon as he gets the feel of the material. Acrylic has working qualities similar to those of brass and copper.

Tools and work should be held firmly to prevent chattering. Standard metal- or woodworking equipment can be used, such as milling machines, drill presses, lathes, planers and shapers. In general, machining tools should be operated at high speeds with moderate feed rates. Tools should be sharp, clean and free of nicks and burrs.

Because it is a thermoplastic material, Acrylic sheet softens when heated to its forming temperature. The frictional heat generated by machining tends to soften the material in the immediate vicinity of the cut, and causes gumming and sticking of the tool or tearing of the plastic if excessive heat buildup occurs. When proper speed, feed and cutters are used, machined Acrylic sheet surfaces will have an even, semi-matte surface, which can be brought to a high polish by sanding and buffing. If tools are sharp and properly ground,
coolants are seldom required for machining Acrylic sheet. They may be desirable for an unusually smooth finish or for deep cuts. If coolants are employed, only detergent in water or a compatible, soluble oil in water should be used. Other coolants may contain chemicals harmful to Acrylic sheet.

Acrylic sheet can be machined to close tolerances and finished parts should be annealed (see page 36, Annealing Acrylic Sheet).

For applications that require both close tolerance and good optical properties, such as periscope prisms and lenses, acrylic blanks should be annealed before and after rough machining. The parts may then be machined to close tolerance, removing as little material as possible. When final machining is complete, the parts should be given a final annealing. Since temperature and humidity affect the dimensions of Acrylic sheet, machining to close tolerance must be done under conditions like those that will prevail when the parts are tested and put into service.

**Turning**

Acrylic sheet can be turned on a lathe to give an excellent semi-matte surface. Surface speeds of 500 feet per minute with feeds of 0.004 to 0.005 inches per revolution will cut a clean continuous chip. If the feed stops, the Acrylic sheet may be marked. The maximum permissible depth of cut is controlled by the rigidity of the section being turned.

Acrylic sheet discs may be turned on a lathe. Circular blanks should be rough cut with a band saw approximately 1/8 inch oversize. The blanks are clamped between the face plate and a tailstock fitted with a live center and a pressure pad. The blanks should be mounted slightly off-center so the waste is thrown clear. The cutting tool should be ground to a rake angle of 0 degrees to 5 degrees. The setup is illustrated in Figure 5.

**Routing and Shaping**

Woodworking shapers (also called table routers) and overhead or portable routers are used in edge-finishing operations and for cutting flat or formed Acrylic sheet parts to size. For edging small parts, the table router is convenient; portable routers are useful whenever the acrylic part is too large or awkward to bring to the machine.

Routers should have a minimum no-load spindle speed of 10,000 rpm. Higher speeds of 20,000 to 25,000 rpm are desirable and should be used when possible. At slower spindle speeds, cutters should have more flutes or larger diameters to produce necessary surface speeds. Double or triple straight-fluted cutters 5/16 to 1/2 inch in diameter will produce good cuts. Smaller diameter cutters should be used with care. If cutters larger than 1/2 inch in diameter are used, the material should be machine-fed rather than hand-fed to overcome chatter. For safety, cutter shanks should be as large as cutters in diameter. Single-fluted cutters should not be used under any circumstances.
ROUTING ACRYLIC SHEET

Portable routers are used for trimming the edges of flat or formed parts, particularly when the part is too large or it is too awkward to use a band saw or stationary router.

Routers should have a minimum no-load spindle speed of 10,000 rpm, and higher speeds are more desirable. Double, straight-fluted cutters 5/16 inch to 1/2 inch in diameter will produce the smoothest cut at this speed. Cutters should be kept sharp and should have a back clearance angle of approximately 10 degrees and a positive rake angle up to 15 degrees. Templates should be provided to guide the router. For extruded acrylic sheet, double or triple, straight, fluted router bits with a maximum diameter of 3/4 inch, a back lip clearance of 10 degrees, and a positive rake angle of about 10 degrees produce good edges. Two fluted edges are recommended. Steel router bits will produce an excellent initial cut, but carbide bits can give a comparable cut and will give many times longer life. The spindle speed required to produce a satisfactory edge is 10,000 to 20,000 rpm. A smooth, constant feed rate of 10 to 25 feet per minute is required to prevent localized heat buildup, which will cause smearing or gumming of the cut edge. Low-horsepower (1-hp) routers should not be used, since they may bind on the material, removing chunks rather than yielding a smooth edge. Avoid using router bits less than 5/16 inch in diameter because smaller-diameter bits tend to clog and break. Use a router setup design that will effectively remove router chips.

Routers with computerized numerical control are favored by some fabricators involved with high-speed production operations.

The Jointer

The jointer is ordinarily used in woodworking shops for the planing of edges and surfaces. It can also be used for the finishing of Acrylic edges prior to polishing and cementing. Because Acrylic sheet is much harder than wood, only a small amount of material should be removed at a time. As a rule, one light pass will be sufficient to clean up a rough saw cut. To obtain a smooth ripple-free finish, all jointer knives must be adjusted to the same height.

Make sure that the rear table is in line with the jointer-knives and that the front table is parallel to the rear table, but approx. 1/32" lower.

The Shaper

A wood shaper can be used for a variety of operations. Edges can be finished on a shaper in the same manner as on a jointer. A standard three-wing cutter will perform well if all cutting edges are ground uniformly to the same diameter.

Always feed the piece against the rotation of the tool. The sheet must be held down firmly to prevent vibration. The rear part of the fence must be in line with the cutting edges, whereas the adjustable front fence is set back 1/64" to 1/32".

Rabbetting is done with straight cutters that have extra clearance at the underside of the cutting edges to prevent burning. Make several small cuts to avoid chipping.

Veneer blades can be used on a shaper to trim formed pieces. Trimming jigs are recommended for production runs.

For beveling with a 45 degree cutter, both fences must be in perfect alignment. Do not attempt to make a complete bevel down to a feather edge. At least 1/32" of the edge (thickness) should be left untouched, to serve
as a bearing edge against the fence.

When machining thick sections of Acrylic sheet, better-quality edges may be produced by using spiral-fluted cutters. Spiral fluted cutters always have a cutting edge in contact with the material and chatter less than straight-fluted cutters. This is done best when the material is held down securely.

**Figure 30**

Carbide-tipped cutters should be used whenever possible since they stay sharp longer than high-speed steel cutters. All cutters should be kept sharp and should have a back clearance of about 10 degrees and a positive rake angle of up to 15 degrees.

The most common operations performed with routers are deflanging and flange trimming. These cuts are illustrated in Figure 6, page 13. Such cuts may be made with router cutters or with veneer saw blades attached to portable or table routers by suitable arbors. Typical deflanging cuts commonly made on formed Acrylic sheet are shown in Figure 7A.

When deflanging cuts must be made to close tolerances, fixtures should be used to support the Acrylic sheet and index the cut. Female fixtures are used for close tolerance referred to the convex side of a formed part; male fixtures, to the concave side as indicated in Figure 7B. The material should be clamped to the fixture. In trimming close tolerance work, the part should not be supported by its flange.

In contrast to deflanging where the entire flange is removed, flange trimming is merely reduction of the size of the flange. Table and panel saws can be used for flange trimming and will produce a good-quality edge. For high accuracy trimming with a table saw, place the part on a lightweight male shape with runners to fit the saw table grooves. Another method is to install a gauging device on the saw fence so that the flange is trimmed by indexing from the outer surface of the return of the part. These methods are illustrated in Figures 8A and 8B.

Portable routers or table shapers equipped with woodworking router bits are also commonly used in this operation. Depending on the equipment used, a template may or may not be necessary.

Figure 9 shows deflanging cuts made with a table router with and without a template. The
lower illustration shows a special router cutter tipped with a ball bearing pilot. This cutter is useful in trimming cemented assemblies. The pilot is the same diameter as the cutter and rides the guiding surface of one part of the assembly as the cutter trims the other.

Another cutting operation using a portable router is shown in Figure 10. A template is cut to size and held to a work table, along with the Acrylic sheet to be cut, by means of air cylinder clamps mounted overhead. The router is fitted with a bushing that enables it to follow the template, cutting only the sheet.

DRILLING
When drilling Acrylic sheet, best results will be obtained using specially ground drills for Acrylic sheet such as Craftics Plas-Drills or Pro Series Drills.

Drilling Techniques
Whenever holes in Acrylic sheet penetrate the stock, Pro Series Drills with a 60 degree tip angle allow the drill to emerge from the second surface without fracturing the sheet.

When holes are to be drilled that do not penetrate the Acrylic sheet, either Plas Drills or Pro Series Drills can be used.
holes with depth to diameter ratios greater than 3:1 should be made with drills having a tip angle of 118 degrees.

Coolant is seldom required when drilling Acrylic sheet, but better surfaces result if coolant is used when drilling large deep holes. Water or a 10 percent solution of a compatible oil in water or kerosene makes a satisfactory coolant and is best fed into the hole by filling a pilot hole nearly as deep as the finished hole. If masked sheet is drilled using coolant, the wet masking paper should be removed promptly. If the masking paper dries in place, a residue may be left behind when the sheet is finally unmasked.

**CRAFTICS EDGE SCRAPER**
This unique tool features four functions in one. Not only will it remove saw marks from flat edges, it also bevels thick and thin material, and will radius the edge quickly and evenly. Stock No. 1106020

**CRAFTICS BUFFING KIT**
Removes haze and fine scratches from plastic surfaces. Also can be used to edge polish. Contains 4" dia. sewn cloth wheel and 2 oz. stick of compound. Stock No. 1106019

**CRAFTICS 1/2" ARBOR ADAPTER**
Allows buffing wheel to be used with any hand held drill.
Stock No. 1106053
Unusually clear and smooth deep holes can be made in Acrylic sheet by filling a pilot hole with a wax stick, then re-drilling to the final diameter. The wax lubricates the cut and supports and expels chips during drilling. A mixture of tallow and kerosene, mixed to the consistency of a slurry, also lubricates well and acts as a coolant.

Large-diameter holes can be cut with hollow end mills, circle cutters or trepanning tools. The cutters of the latter should be ground to 0 degree rake angle and adequate back clearance, just as lathe tools are ground.

Acrylic sheet may be drilled using any of the conventional tools: portable electric drills or flexible shafts, drill presses or lathes. The drill should always run true since wobble will affect the finish of the hole. When drilling holes that penetrate the second surface, it is desirable to back up the sheet with wood and slow the feed as the drill point breaks through. For accuracy and safety, Acrylic sheet should be clamped during drilling.

Tapping and Threading
Standard machine shop tools and procedures may be used for tapping and threading.

Wherever possible, the “national coarse thread” system should be applied. On diameters over 1 inch, Acme threads are preferred to V-threads. The root should be radiused.

When transparency is a requirement for the tapped threads, a wax stick should be inserted in the drilled holes before tapping. As in drilling, the wax lubricates the cuts and supports and expels the chips, resulting in cleaner, more transparent threads.

Taps should be backed out often to clear the chips. The wax stick is particularly useful for blind holes since it tends to clean out the chips as they are formed.

FINISHING ACRYLIC SHEET
Acrylic sheet should be handled carefully to avoid scratching its surface. It is easier to avoid scratches than to remove them. Scratched surfaces can be restored to a good finish by a process of polishing and/or sanding. Sawed edges and machined surfaces can also be polished to a high gloss. Where power-operated polishing equipment is not available, it is possible to hand-polish minor scratches from the surface of the sheet. Minor scratches

---

**Craftics Plas-Drills**
High speed drills with 90° point and 0° rake for working with plastics: no chipping, cracking or grabbing. Designed for use in hand power drills. Reduced shank to 3/8" on sizes 7/16" & 1/2".

<table>
<thead>
<tr>
<th>Stock No.</th>
<th>Size</th>
<th>Stock No.</th>
<th>Size</th>
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<tbody>
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</tr>
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<td>1/2&quot;</td>
</tr>
</tbody>
</table>

**Craftics Pro Series Plas-Drills**
These drills incorporate a different fluke, 60° point and 0° rake and are designed for use in drill presses. The ultimate for high speed drilling of plastics with extended usage. Reduced shank to 1/4" on sizes 5/16", 3/8", 7/16" & 1/2".

<table>
<thead>
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<th>Size</th>
<th>Stock No.</th>
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<td>1/4&quot;</td>
<td>1106545</td>
<td>1/2&quot;</td>
</tr>
</tbody>
</table>
can be polished by rubbing with a soft cloth and Craftics 20/20 Polish.

Before sanding, buffing or polishing use Craftics 20/20 Plasti-Cleaner to clean the Acrylic sheet carefully. The buffing wheels and compounds should also be free from dirt and grit. Separate buffs should be reserved for Acrylic sheet. They should be cleaned by running the buffing wheel against a hard metal edge to remove hardened tallow, grease or other binders.

The friction of buffing, sanding or polishing too long or too vigorously in any one spot can generate enough heat to soften or “burn” the acrylic surface, resulting in visual distortion and possibly discoloration. To avoid this, keep the Acrylic sheet constantly in motion relative to the wheel, use light pressure, and change the direction of buffing often. Air-cooled buffing wheels are often used to help reduce heat of friction.

Polishing techniques vary with the equipment available and the size or shape of the acrylic parts being polished.

Sanding and buffing cause thickness variations in the scratched area of the Acrylic sheet. If skillfully done, these operations cause only minor optical distortions that should not be objectionable for most applications. In critical sections, even minor distortions may not be acceptable. Such sections, even though scratched, should not be sanded or buffed. They should be simply cleaned and polished. However, applications that must be sanded should be sanded by hand, using progressively finer grit paper up to grits of 12,000. These grits are available as cushioned abrasive cloth.

**Sanding**

If there is a scratch in the Acrylic sheet, it should not be sanded unless the surface imperfections are too deep to be removed by light buffing and the resultant optical distortion can be tolerated. The way to tell if sanding is necessary is to rub your fingernail over the scratch. If it can be felt, then sanding is required. Use the finest sandpaper that will remove the imperfections. Coarse paper can cause scratches deeper than the original imperfection, and additional finishing operations will be needed.

First try using 600 grit sandpaper wrapped around a sanding block. Sand over the scratch using increasingly larger areas of sanding. If this does not readily remove the scratch, step down to 400 grit. The sanding should be done in directions mutually 30 degrees apart to produce a diamond pattern. After sanding and stepping up to 600 grit, polish the sheet as described below.

Do not use disc or belt sanders dry. The greater danger of heat generation with mechanical sanders makes the use of water or oil coolants doubly desirable. Wet sanders are preferred, but dry orbital sanders can be used with care. Open coat sandpaper should be used, since it does not become clogged as fast as closed coat sandpaper. Craftics Polishing and Scratch Removal Kit is ideal for this. The kit contains 1/2 oz. 20/20 Plasti-Polish, 1/2 oz. 20/20 Plasti-Cleaner, polishing cloth, sanding block, 150 grit and 600 grit sandpaper and instructions.

**Machine Buffing**

The Acrylic sheet should be clean and dry at the start of each buffing operation. Some polishing compounds leave the surface clean after buffing. If these materials are not used, washing should follow the last step in polishing.

If the part has previously been sanded or is deeply scratched, an abrasive coated wheel is used first. The abrasive is a standard polishing
compound composed of very fine alumina or similar abrasive and tallow.

When most of the scratches have been reduced on the first wheel, the Acrylic sheet is buffed on the second wheel charged only with tallow. These first two wheels should be air-ventilated cotton muslin rag wheels and should operate at 3,000 to 4,500 surface feet per minute (SFPM). To calculate: SFPM equals 1/4 the diameter of buffing wheel in inches multiplied by the spindle speed in rpm.

The Acrylic sheet is next brought to a high polish by a soft, loose buff in which no abrasive or tallow is used. These cleaning buffs should be very loose and should be made of imitation chamois or cotton flannel. The wheels should be 10 to 12 inches in diameter and should run at 3,000 to 4,500 SFPM. A hand-applied coat of wax may be used in place of buffing on the finish wheel, if desired.

Polishing Drilled Holes

A properly drilled hole has a smooth semi-matte finish that can be brought to a high polish. A wood or metal rod approximately 1/8 inch smaller in diameter than the drilled hole is split to a depth equal to the depth of the hole plus 1/2 inch and mounted in a drill press. If the inner surface of the hole is rough, steel wool or strips of emery cloth or sandpaper are wound around the rod and gripped in the slot. When the inner surface is smooth, a good grade of flannel is wound around the rod and the compounds for buffing are applied. Poor grades of flannel may throw lint and require further cleaning.

Polishing Edges

In many installations, the edges of Acrylic sheet are completely hidden in a mounting frame or channel and smooth edges, free of chips and major irregularities, are entirely satisfactory. Sometimes good machine-finished edges are used as a decorative element in the design of a part made of Acrylic sheet. Well-polished edges, however, may be required for household accessories, jewelry, and other decorative items.

Saw marks can be removed from the edges of Acrylic sheet by scraping with a Craftics Edge Scraper. After scraping, the edges should be sanded on a wet belt sander with 320 grit then 400 grit sandpaper.

A fast method to polish Acrylic sheet is to make buffs of layers of medium density 100 percent wool felt about 3/16 to 1/4 inch thick. The felt should have a specific gravity of about 0.27. The wheels should be 10 to 12 inches in diameter and should be held between hard faceplates about three inches smaller in diameter than the buff. The wheels should be run at a speed of 3,000 - 4,500 SFPM.

The edges are buffed on a felt wheel charged with abrasive and tallow. The final polish is given to the edges with a soft cotton buff. Felt wheels should not be used on large flat areas since there is a tendency to burn and distort the sheet.

Whenever possible, a number of Acrylic sheet parts should be locked together in a jig leaving only the edges exposed, so that the edges may be planed, sanded, and polished simultaneously. This technique is faster and gives better results without rounding the edges. Lapidary wheels surfaced with high-density felt may also be used for polishing flat surfaces.

To prevent heat buildup, the sheet may be buffed with a paste or liquid wax with an abrasive.

Flame Polishing

Flame polishing is a fast, economical method of edge polishing that is preferred by some fabricators, but it cannot be fully recommended for use on Acrylic sheet, because of its tendency to cause crazing which is often not apparent until sometime after the article has left the fabricator's shop. This technique is never recommended if other fabrication steps, such as cementing, forming, or painting, are planned after the polishing step. Do not use plastic cleaner before flame polishing only after.

The flame should be bluish, nearly invisible, approx. 4" long, and narrow. Hold the torch so that the tip of the flame touches the edge of the Acrylic sheet. Move the torch along the edge at a speed of approx. 3" - 4" per second.
Overheating and bubbling may occur if the flame is moved too slowly. If the first pass does not produce a completely polished edge, allow the piece to cool; a second pass will often improve the surface finish.

**Repairing Cracks**

If a crack has started at the edge of a sheet, you must drill, as soon as possible, a small hole (1/8" to 1/4" dia.) 1/16" away from the end of the crack. This will prevent the crack from continuing into the sheet. After the hole has been drilled, you can cement a small piece of Acrylic over the crack to reinforce the entire area.

**FORMING**

**Cold Forming**

Acrylic can be cold formed within certain limitations. It can be forced, at normal temperatures, into a curved channel or frame. The minimum radius of curvature must be at least 180 times the thickness of the sheet. If a sheet is formed into smaller (tighter) curvatures than those listed below for various thicknesses, the resulting internal stresses may cause crazing.

<table>
<thead>
<tr>
<th>Sheet Thickness</th>
<th>Minimum Radius of Curvature</th>
<th>Equal to Circle of</th>
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<tr>
<td>1/16&quot;</td>
<td>11&quot;</td>
<td>22&quot; Dia.</td>
</tr>
<tr>
<td>1/8&quot;</td>
<td>22&quot;</td>
<td>44&quot; Dia.</td>
</tr>
<tr>
<td>3/16&quot;</td>
<td>33&quot;</td>
<td>66&quot; Dia.</td>
</tr>
<tr>
<td>1/4&quot;</td>
<td>45&quot;</td>
<td>90&quot; Dia.</td>
</tr>
<tr>
<td>3/8&quot;</td>
<td>68&quot;</td>
<td>136&quot; Dia.</td>
</tr>
<tr>
<td>1/2&quot;</td>
<td>90&quot;</td>
<td>180&quot; Dia.</td>
</tr>
</tbody>
</table>

**Heat Forming**

Acrylic is a thermoplastic material. When it is heated to approx. 340 degrees F., it becomes soft and pliable and can be formed into almost any shape; as it cools, it will harden and retain the formed shape. Because Acrylic is thermoplastic, it can be re-heated and will again become flat.

Many methods can be used to form Acrylic. They can be divided into three basic groups:
- Strip heating of line bends.
- Drape forming of two-dimensional curves.
- Stretch forming of three-dimensional shapes.

**Strip Heating of Line Bends**

If a sheet of Acrylic is to be bent along a straight line, it is best to use a strip heater or a tubular heater which will heat only the narrow area that has to be formed. There is no need to heat the entire sheet in an oven if you want to form an angle.

By using a strip heater, you will not only save time, but you will also obtain better results. Because the piece stays cold, except for the narrow heated area in the center, both sides of the angle will remain flat and not show any distortions. However, bowing can result from uneven heating or uneven cooling. Pieces longer than 24" will also have a tendency to bow.

**Equipment**

If you wish to make a sharp bend in a thin sheet, a tubular (rod) heating element should be used. For wider bends (larger radii), flat strip heaters are more suitable.

If you intend to bend only a few pieces, place the heating element on top of two sheets of asbestos board (Transite) and place several sheets of Transite on both sides of the heating element to support the Acrylic sheet. For temporary use, two pieces of plywood can be used instead of the Transite to support the Acrylic sheet. Plywood supports, however, will heat up soon and start to burn.

The sheet should be at least 1/4" away from the heating element to prevent overheating of the surface. By changing the distance between the supports, you can increase or decrease the width of the heated area, and thereby vary the curvature of the bend.

A good strip heater for hobbyists or craftsmen is the Craftics® Plastrip Heater. The strip heater is placed over the sheet of
acrylic (up to 1/4” thick). A one inch wide strip of the masking paper is removed from both sides where the bend is to be made.

The acrylic is placed on a heat resistant work surface with the Plastrip Heater on top of the acrylic. Another piece of heat resistant material is placed over the heater to keep it in contact with the acrylic. Be sure there is continuous contact between the heater and the acrylic.

Plug in the heater, and heat the acrylic until it is soft enough to bend without having to apply excessive pressure. This could take up to 30 minutes for 1/4” thick material, depending upon the insulating material.

Bend the sheet to the desired angle and hold it in place until the acrylic cools. A square bar may be used for sharp bends or a round dowel rod for radius bends.

**Operation**

The masking paper must be removed before the piece is placed on the heating unit. If additional machining or trimming is to be done after bending, it may be advisable to remove the masking paper only from the area that is to be heated.

If you want a narrow bend (small radius), keep the sheet close to the heater (the minimum distance is 1/4”), and decrease the width of the heated area by covering the top of the heating unit with one or two pieces of Transite or laminated phenolic. If you require a large bending radius, increase the opening at the top and the distance between the heater and the Acrylic sheet.

For best results, the sheet should be turned over several times so that it will be heated on both sides. This is especially important for sheets 3/16” and thicker. For production runs of sheets over 3/16”, it may be better to heat both sides simultaneously by using two heaters.

Heating time will vary from 1 to 30 minutes, depending on the thickness of the Acrylic sheet, the type of heating unit, and the distance between the unit and the sheet.

Avoid overheating as it will cause the surface to burn and blister. Until you have established the best heating and forming cycle, you must test the piece repeatedly to determine whether it is soft enough for bending. As soon as you feel that you can form it without forcing, place it in a cooling jig. A simple cooling jig consists of two cleats nailed to a board or to the work bench. By varying the distance between the cleats, you can change the angle of the piece.

Do not attempt to heat acrylic with an open flame or kitchen appliances. For safety, use in a ventilated area, and have a dry chemical fire extinguisher near by.

**Drape Forming of Two-Dimensional Curves**

Two-dimensional curves are formed by draping a uniformly heater sheet over a mold and permitting it to cool while it is held against the mold.

The sheet can be heated in an oven or with infra-red heating units. Heating in a thermostatically controlled circulating-air oven
is far superior because the sheet will be heated slowly and uniformly.

Ovens
Forced circulating-air ovens will provide uniform heating at constant temperatures. Baffles and electric fans are used to distribute the heat evenly. Such ovens are commercially available from several manufacturers. They are frequently of vertical construction and are equipped with monorails from which the sheets can be hung.

If your production does not warrant the purchase of such an oven, you can build a simplified version in your own shop. The oven consists of an outer and an inner shell with a 2" space between them. This space is filled with fiberglass or rock-wool insulation. The oven is heated by several 1000-Watt strip heaters which are thermostatically controlled. A fan should be installed to produce even heating for deep-drawn parts.

If the average size that you intend to form will not be larger than 24" x 36", you can build a horizontal oven with inside dimensions of approx. 48" x 36", by 24" high. This size will require four or five 1000-Watt strip-heaters. The oven should be equipped with four horizontally hinged, insulated doors and two removable, reinforced sheet metal trays. The trays are covered with fine-weave fiberglass cloth and then with one or two layers of drill cloth or flannel. The Acrylic sheet must never be placed on the bare metal tray or on the fiberglass cloth as this would result in severe "mark-off".

Infra-Red Radiant Heating
It is quite difficult to obtain an even distribution of heat with a bank of infra-red lamps. However, if you use lamps, they should be positioned approx. 18" from the material, and moved back and forth in order to avoid "hot spots". Relector-backed, tubular infra-red elements will give more uniform heat.

Because acrylic plastics absorb most of the infra-red energy on the top surface, and because all plastics conduct heat slowly, the surface will be much hotter than the center of the sheet. Therefore, single-sided infra-red heating should not be used for sheets over 1/8" thick. Heating will be more uniform if the space between the infra-red unit and the Acrylic sheet is enclosed on all four sides.

Molds for Two-Dimensional Shapes
Molds can be made of white pine, mahogany, Masonite die stock, sheet metal, heavy cardboard, or of a combination of these materials.

The simplest form consists of two cleats nailed to a board. The curvature is controlled by the distance between the two cleats and by two contour ribs that are placed at both ends as shown.

If the curvature is not circular but somewhat irregular, you will need a more substantial form to control the shape of the piece. The form shown below consists of four ribs cut to the contour of the required piece from 3/4" plywood. The four contour-ribs are connected by two tie-rods and mounted on a plywood base. This framework should be covered with thin sheet metal or heavy cardboard. To avoid "mark-off", cover the form with flocked rubber, felt or flannel.

Molds are usually somewhat longer and slightly higher than the finished piece to allow
for contraction after cooling.
The two long edges of the formed piece should be held against the mold by two bars and wedges, as the hot sheet has a tendency to curl away at the edges.

General Recommendations
Acrylic sheets will shrink approximately 2% when heated. Therefore, you must cut the blanks approx. 2% larger than the required size, to allow for shrinkage.

If very accurate dimensions are to be maintained, the piece should be formed oversize and then trimmed to the exact dimensions.

However, if the outside dimensions are not too critical, it will be more economical to allow for shrinkage and to increase the blank size accordingly so that additional trimming and finishing can be avoided.

The masking paper must be removed before the sheets are placed in the oven. Any residue of masking adhesive that remains on the sheet must be washed off. If a piece requires trimming or additional machining after it has been formed, re-masking may be necessary. In order to be able to use the paper again, remove it carefully and roll it onto a cardboard tube. Complex shapes can be protected by spray-masking with “Spraylat”.

Heating and Forming
It is essential that the Acrylic sheet be thoroughly and uniformly heated before forming, and that forming may be completed before the temperature of the heated piece has dropped below the minimum forming-temperature. If a piece that is just beginning to harden is forced onto a mold, internal stresses or crazing may result.

On the other hand, when a piece has become overheated because the oven temperature was too high or because it remained in the oven too long, its surface will be too soft. It will then pick up minor imperfections (called “mark-off”) from the mold surface and from the cotton gloves of the operator. “Mark-off” must be avoided as extensive polishing is required to remove it. If the piece must have an optically perfect surface, it will be cheaper to re-heat the piece than to polish out the “mark-off”.

Formed acrylic parts have an “elastic” or “plastic” memory and can be re-heated repeatedly to forming temperature. They will soften and again become flat. Re-heating will not cause additional shrinkage.

The oven temperature should be accurately controlled between 320°F - 340°F, and based on a heating cycle of approximately 10 minutes for a sheet 1/10” or 1/8” thick. The heating time can be reduced by raising the oven temperature. However, this will cause overheating of the surface and will increase mark-off.

Acrylic that has been properly heated feels like a sheet of soft, pure rubber. The best heating cycle can be determined by forming a few test pieces.

The sheet should be heated thoroughly, but you should let the surface cool slightly by waving the sheet in the air for 10 to 30 seconds, depending on the thickness.

Keep in mind that thin sheets will lose heat faster than thick sheets and therefore must be formed quickly, before their temperature has fallen below the minimum forming-temperature.

The formed part should be allowed to cool slowly and uniformly. This can be accomplished by covering the piece with a soft blanket. The formed piece must not be removed from the mold until it has cooled to below 175°F.

CEMENTING ACRYLIC SHEET
Health and Safety Precautions
Cements described in this bulletin contain volatile components which may be harmful if sufficient concentrations are inhaled for extended periods of time, absorbed through the skin, or swallowed. All cements should be used only in well-ventilated areas which keep exposure levels below acceptable limits. Excessive exposure to cement vapors may cause drowsiness, dizziness, intoxication, or nausea, and in extreme cases, more serious reactions may occur.
Studies conducted under the auspices of the National Toxicology Program have discovered that methylene dichloride and/or methylene chloride (MDC), common components of solvent cements, may be an animal carcinogen. The extension of these results to humans is currently undergoing review among a number of federal agencies and other interested parties. At this time, it is not clear what recommendations regarding use or permissible exposure limits may emerge from this review.

In the meantime, anyone using cements containing MDC, should contact the manufacturer or supplier of the solvent or cement for specific information on the safe use and precautions necessary for each solvent or cement. The Material Safety Data Sheet (MSDS) should be obtained and reviewed before using any solvent or cement.

Volatilization can be reduced by the use of a closed applicator bottle such as one of the Craftics Plasticators. Other methods are more prone to produce objectionable vapors. For example, the soak or dip method of solvent cementing, which requires an open tray or soak tank for the solvent, should not be used unless a tank cover with a cutout for the part to minimize solvent evaporation and an adequate exhaust system to ventilate the area and remove vapors are employed.

In cases of overexposure to any cement vapors, the patient should be removed from the area, wrapped in a blanket, given plenty of fresh air and prompt medical attention.

Because most vapors from the cementing process are heavier than air, some ventilation should be provided at floor level. The fabricator should become familiar with the hazardous properties of the cements and provide all precautions necessary for their safe use. Material Safety Data Sheets are available from the manufacturer for these purposes.

If the skin comes into contact with one of the cements, chapping and/or mild dermatitis may occur. Immediately after contact, the exposed area should be thoroughly washed with soap and water.

Clothing that has come in contact with the cement should be removed immediately and washed before re-wearing. If cement enters the eyes, they should be flushed with copious amounts of water and given prompt medical attention.

If a cement containing methylene chloride (e.g., MDC, or the generic unthickened cement described on page 27) is swallowed, vomiting should not be induced and a physician should be called. If other cements recommended herein are swallowed, immediately call a physician for advice on whether or not to induce vomiting.

Care must be taken to mix the cements in the proper order as given in the manufacturers' instructions. Deviation from the proper order of mixing may result in a violent reaction causing an explosion or a fire.

Many of the cements are flammable. All the cements must be kept away from open flame or sources of high heat. There should be no smoking in any area in which the cements are stored or used. In case of fire, only dry powder or chemical fog fire extinguishers should be used.

**CEMENTING**

Pieces fabricated from Acrylic sheet may be joined using mechanical methods such as bolts, thermal methods such as welding, or chemical methods such as cementing. The following sections discuss the techniques commonly used to cement Acrylic sheet to itself and to other materials.

Cementing Acrylic sheet is relatively easy, but proper techniques must be practiced to avoid problems. The two most common problems are crazing and poor joint strength.

Acrylic plastics will eventually craze when subjected to high stresses for a long time. Crazing is a network of fine cracks running, on or slightly under, the surface of plastic materials. The tendency to craze is greatly increased when the stressed material is exposed to a solvent or to solvent vapors. Most of the cements described in this manual may craze Acrylic sheet if used improperly.

Stress may be introduced into a part during the thermoforming operation, or during fabrication operations such as machining or polishing. Stress may sometimes be held to a minimum by altering the processing
conditions when forming parts, and by using sharp tools of the recommended types when cutting or machining. The possibility of crazing may be greatly reduced by minimizing internal stresses by annealing the parts before cementing. Low joint strength may be due to a number of causes. Improper fit of parts, inadequate mixing of the cement, excessive clamping pressures, or poor technique may all help weaken cemented joints. The best way to avoid problems is to follow the recommendations in this manual.

Preparation of the joint is very important when cementing extruded acrylic sheet. The parts must fit accurately and smoothly without forcing. If the parts do not match or fit well, the edges to be cemented should be machined smooth to fit, but should not be polished since polishing tends to round edges. Proper preparation of edges is necessary to ensure that little or no internal stress is present in the material. Such stresses will cause crazing on contact with solvent. To prevent crazing, avoid flame polishing and dry belt or disc sanding where solvent contact may occur.

**Cementing Acrylic Sheet to Acrylic Sheet**

Cementing provides a versatile and simple method for joining pieces of Acrylic sheet. Properly cemented assemblies of Acrylic sheet have nearly the appearance of a single piece; however, cemented areas of colored material, especially white translucent colors, may deviate from the original color when the joints are viewed under certain reflected or transmitted light conditions.

Cementing permits the manufacturing of parts that cannot conveniently be made by other methods because of process limitations (e.g. part size, undercuts), low production volume, or cost. Good cemented joints are also air- and water-tight.

The two types of cement used for Acrylic sheet are solvent cements and polymerizable cements. The solvent cements may be used as supplied, or may be thickened with Acrylic sheet chips or Acrylic molding resin. Polymerizable cements, such as Weld-On 40, are viscous as supplied. Also recommended is an unthickened solvent/polymerizable cement, a formulation consisting of 60 percent methylene chloride and 40 percent MMA monomer and requiring a 50 percent strength benzoyl peroxide as a catalyst for proper use. This cement will be referred to in this section as “generic unthickened cement.” This formulation may be thickened with Acrylic sheet chips or Acrylic molding resin.

Solvent cements work by softening and swelling the Acrylic sheet, permitting actual cohesion of the parts. After assembly, the solvents evaporate or dissipate through the material, leaving a hard, clear joint. Thickened solvent cements work the same way, but allow for longer solvent action due to slower evaporation, limit capillary flow between two closely fitted surfaces, and provide limited gap-filling capability. The polymerizable cements have little or no solvent action, but actually form new polymer in the joint, thus holding the parts together.

Both cast and extruded acrylic sheets may be cemented with either solvent or polymerizable cements. Generally, however, a polymerizable cement, such as Weld-On-40, provides better joint strength and appearance.

Any of the unthickened cements may be used if the parts will not be used outdoors. The choice may be governed by the availability of the solvent or by previous experience with a particular cement. MDC has been used on parts placed outdoors, but the generic unthickened cement should be used if colorless joints with maximum strength and outdoor durability with unthickened cements are desired. (Weld-On-40 is best for outdoor use, however.)

**Solvent Cements**

Depending on technique, cast acrylic surfaces to be joined are softened, and in some cases swollen into a cushion, by contact with solvent cements. Extruded acrylic sheet should not be soaked in cement as long as cast acrylic sheet, for it tends to dissolve rather than swell into a cushion.

Since solvents evaporate at different rates, the composition of cements made from a mixture of several solvents should be periodically
checked to maintain correct proportions. In many cases, checking the specific gravity with a calibrated hydrometer may be adequate.

The surfaces to be cemented may be left as cast, sanded (either wet or by hand), scraped, or machined according to methods described in Machining Acrylic Sheet, page 11. The edges to be cemented should not be polished, as this may cause crazing when the cement contacts the edges. The pieces should fit accurately without forcing or flexing. Well-fitted parts produce stronger joints.

If a part is to be immersed in solvent, the softening action of the cement must be confined to the area of the joint by masking the surrounding Acrylic sheet. Tapes, gelatin solutions, or commercially available masking compounds that are impervious to the action of the cement, may be used to mask the material. The part to be masked is coated with the mixture, so a fairly thick film adheres to it. The coated piece is hung until it cools and dries. When the film is no longer tacky, it is stripped from the areas to be cemented with a razor, taking care to avoid scratching the surface of the plastic. The edge of the part is then soaked and assembled, and the remaining film is stripped from the material. The glue may be reused several times.

The temperature and humidity conditions in the cementing room, and the temperature of the parts to be cemented are important. Unthickened cements should not be used at temperatures below 65°F. Low temperatures reduce the solvent action and increase the soak time, increasing the possibility of crazing. The most desirable conditions are normal room temperatures and low relative humidity. Excessive moisture may cause the joints to become cloudy. Adding 10 percent diacetone alcohol to MDC will reduce blushing in humid conditions.

The generic unthickened cement forms solid polymer in the joint, which enables it to outperform straight solvent cements whose action depends solely on their power to soften Acrylic sheet. The same general techniques used with straight solvent cements are used with the generic unthickened cement. Although the joint strength obtained with this formulation without heat treatment is adequate for most applications, greater joint strengths may be obtained by heat treating the joints after assembly. Graph 1 shows the effect of heat treating generic unthickened cement joints at various times and temperatures.

Because the methylene chloride in the generic unthickened cement and cement 7-2-1 (70% Methylene Chloride, 20% MMA Monomer (inhibited), 10% Glacial Acetic Acid) evaporates more rapidly than the methacrylate monomer, the composition must be maintained by adding methylene chloride to
restore the specific gravity of the mixture. This specific gravity should be checked every four hours under ordinary conditions of use, and more often if the four-hour check shows excessive change in composition. No specific gravity value is given for Cement 7-2-1 mixture since three components are involved. Any signs of the mixture yielding weak joint strengths can usually be overcome by adding incremental amounts of methylene chloride to the weakened mixture.

<table>
<thead>
<tr>
<th>PERMISSIBLE RANGE OF SPECIFIC GRAVITY</th>
<th>TEMPERATURE °F</th>
<th>°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.17 - 1.21</td>
<td>68</td>
<td>20</td>
</tr>
<tr>
<td>1.16 - 1.20</td>
<td>77</td>
<td>25</td>
</tr>
<tr>
<td>1.15 - 1.19</td>
<td>86</td>
<td>30</td>
</tr>
<tr>
<td>1.14 - 1.18</td>
<td>95</td>
<td>35</td>
</tr>
</tbody>
</table>

Uncatalyzed generic unthickened cement and Cement 7-2-1 have a shelf life of one year if stored in a closed container at room temperature. The contents of one 2.4-gram capsule of a 50/50 mixture of benzoyl peroxide and stabilizer must be added to each pint of the generic unthickened cement before use. This formulation will eventually thicken after the catalyst is added; however, the time that the catalyzed cement remains usable depends on the storage conditions as shown in Table 5. The cement must be stored in closed containers to prevent the loss of methylene chloride. Because of the acetic acid in Cement 7-2-1, its storage container must be corrosion-resistant, such as glass or plastic-lined metal. MMA monomer is highly flammable and should not be stored or cured near an open flame.

**TABLE 5: Storage Conditions for Generic Unthickened Cement**

<table>
<thead>
<tr>
<th>Storage Temperature</th>
<th>Shelf Life of Catalyzed Generic Unthickened Cement</th>
</tr>
</thead>
<tbody>
<tr>
<td>104°F</td>
<td>3-1/2 days</td>
</tr>
<tr>
<td>77°F</td>
<td>45 days</td>
</tr>
<tr>
<td>41°F</td>
<td>5 months minimum</td>
</tr>
</tbody>
</table>

**Thickened Cements**

Thickened solvent cement is made by adding clean Acrylic sheet chips or Acrylic molding resin to a solvent to produce a syrupy cement which can be applied like glue. Acrylic VS-100 acrylic molding resin dissolves more readily than other molding resin grades or cast sheet chips, producing a cement with a higher solids content. The solvent in the thickened cement swells both surfaces to be cemented, to permit the formation of the bond. The joint hardens as the solvent evaporates or dissipates through the material. The viscous cement acts as a carrier for the solvent; since the solids content is too low to fill any sizeable voids without developing bubbles. The parts should fit as closely as possible to minimize bubbles and maximize joint strength.

Thickened cement should primarily be used as a perimeter cement. If parts fit well it will run under only 1/16 inch and give a neat appearance. This should be for indoor use only. Thickened cements should only be used to minimize run-under by capillary action when perimeter-cementing appliques, to increase solvent attack of a solvent-resistant material, or to join two parts that cannot be feasibly made to fit closely. If the part to be cemented requires soaking in a tray or on a saturated pad of solvent cement, limit the soak time to 1-1/2 minutes to obtain the best joint appearance (minimal squeeze-out) and optimum set time.

If areas are cemented they should be small, as large areas show many bubbles when dry. Large areas may require eight hours or more to dry.

**Polymerizable Cements**

Polymerizable cements are those in which a catalyst is added to an already thick monomer/polymer syrup to promote rapid hardening. Weld-On 40 is a polymerizable cement of this type. It is suitable for cementing all types of Acrylic sheet. At room temperature, the cement hardens (polymerize) in the container in about 45 minutes after mixing the components. It will harden more rapidly at higher temperatures. The cement joints are usually strong enough for handling one or two
FIGURE 12A: Open "V" Joint Polymerizable Cementing

1. Prepare Parts for Cementing.

Scrape edges
1/4"-5/16" wide tape, adhesive down
1" wide tape to hold cement.

CAUTION: Make sure that the tape does not affect the hardening or color of the cement.

2. Pour Cement.

Overfill to allow for cement shrinkage as it hardens.

NOTE: Bottom fillet may not require finishing in many applications.

Keep nozzle of dispenser deep in joint to insure complete filling.

Dispenser motion
Tape folded up to seal end.

1/8" - 3/16"

1/8" - 3/16"

1/16" - 1/16"

FIGURE 12B: Open "V" Angle Joint Technique

Position pieces with small clearance not greater than .015". This clearance must be kept to prevent a dry notch. Paper, small wire, etc., may be used to position the parts prior to clamping. Remove spacers before cementing.

1. Position parts for cementing.

Dispenser

Inside edge of joint is filled by capillary action.

2. Pour cement.

Overfill to allow for shrinkage.

3. Allow cement to harden.


5. Final finishing, sanding, buffing, etc.
FIGURE 12C - Open "V" Angle Construction Variations

Configuration of joints to be subjected to internal pressure such as by air or water.

Make joint as shown in Figure 12B

Second Fillet

0.250" or Thinner

NOTE: The unfinished surface of PS-30 will tend to become cloudy

Material Thicker than 0.250"

0.250"

VARIOUS ANGLE CONFIGURATIONS

V

Second Fillet

FIGURE 13 - Box Construction Using Polymerizable Cement

1. Cement sides together.

Pieces clamped to fixture for cementing.

Pour one joint at a time.

Support

Cementing fixtures

Pour two joints at same time.

2. Remove excess material from sides (see Figures 14A and 14B).

3. Add end.

4 Finish entire box.
hours after assembly depending upon part configuration. The joints may be machined four hours after assembly, but it is better to wait 24 hours.

Weld-On 40 joints retain excellent appearance and color stability after outdoor exposure. This cement produces clear, transparent joints and should be used when the clarity and appearance of the joints are important.

Weld-On 40 should be used at temperatures no lower than 65°F. If cementing is done in a room cooler than 65°F, it will require a longer time to harden and the joint strength will be reduced. The cement should be prepared with the correct proportions of components (preferably fresh) as given in the supplier's instructions and thoroughly mixed, making sure neither the mixing container nor mixing paddle adds color or affects the hardening of the cement. Clean glass or polyethylene mixing containers are preferred.

Adding about 10 percent (by weight) Acrylic
VS-100 molding resin will reduce shrinkage of the cement during polymerization, but also decreases joint strength slightly. The pellets must be thoroughly dissolved before mixing the components.

Because of the short pot life (approximately 45 minutes), Weld-On 40 must be used quickly once the components are mixed. Time consumed in preparation shortens the effective working time, making it necessary to have everything ready to be cemented before the cement is mixed. For better handling, pour cement within 20 minutes of mixing.

For maximum joint strength, the final cement joint should be free of bubbles. It will usually be sufficient to allow the mixed cement to stand for 10 minutes before cementing to allow bubbles to rise to the surface.

To remove the bubbles quickly, spin the cement with an electric drill. This is done by drilling a hole in the center of a metal jar cap and placing a bolt through it, then placing a
nut on the outside. This bolt is gripped by the chuck of an electric drill. Screw jar into cap and spin cement for one minute. This is for up to 6-ounce jars only. For large sizes, a centrifuge that contains the jar should be used.

The gap joint technique should only be used with colorless Acrylic sheet, or in cases in which joints will be hidden, or when light leaks are not a problem. Inconspicuous joints in colored sheet are difficult, if not impossible, to achieve. Adding acrylic sign paints to Component A can be effective at times, but may adversely affect the joint strength.

Cement forms or dams may be made with masking tape as long as the adhesive surface does not contact the cement. This is most easily done with a strip of tape placed over the masking tape adhesive. The tape must be chosen carefully. The adhesive on ordinary cellophane tape prevents the cure of Weld-On 40. Before actual fabrication of parts, sample joints should be tried to ensure that the tape system used will not harm the cement. Since it is important for all the cement to remain in the gap, only contact pressure should be used. Types of joints are shown in Figures 12A, 12B and 12C. Figure 13 combines the joints into a box construction.

Bubbles will tend to float to the top of the cement bead in a gap joint after the cement is poured. These cause no problem if the bead is machined off. A small wire (not copper), or similar object, may be used to lift some bubbles out of the joint; however, the cement joint should be disturbed as little as possible.

CRAFTIES POLY SYRINGE APPLICATOR
For the fabricator who likes the precision of a calibrated syringe for applying solvents. Available in two sizes: 5cc. and 30cc., both available with our selection of needles.

<table>
<thead>
<tr>
<th>5 cc SYRINGE</th>
<th>30 cc SYRINGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1106037</td>
<td>1106035</td>
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<td>27 Ga.</td>
<td>27 Ga.</td>
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<tr>
<td>1106076</td>
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<td>1106034</td>
<td>1106038</td>
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<tr>
<td>16 Ga.</td>
<td>16 Ga.</td>
</tr>
<tr>
<td>1106047</td>
<td>1106040</td>
</tr>
<tr>
<td>20 Ga.</td>
<td>20 Ga.</td>
</tr>
<tr>
<td>Solvent Adhesives for Plastics</td>
<td></td>
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<tr>
<td>-------------------------------</td>
<td></td>
</tr>
<tr>
<td><strong>CRAFTICS PLASTICH SOLVENT CEMENT</strong></td>
<td></td>
</tr>
<tr>
<td>Fast setting, clear adhesive for joining acrylic to acrylic. Invisible when dry for clear joints.</td>
<td></td>
</tr>
<tr>
<td>1106002</td>
<td>2 oz.</td>
</tr>
<tr>
<td>1106010</td>
<td>8 oz.</td>
</tr>
<tr>
<td>1106012</td>
<td>16 oz.</td>
</tr>
<tr>
<td><strong>CRAFTICS THICKENED ACRYLIC CEMENT #33</strong></td>
<td></td>
</tr>
<tr>
<td>A clear syrup cement for joining acrylic to acrylic where high strength joints are needed. Rapid setting, overnight cure formulation in easy to use squeeze tube.</td>
<td></td>
</tr>
<tr>
<td>1106031</td>
<td>1-1/2oz.</td>
</tr>
<tr>
<td><strong>4 IPS ACRYLIC CLEAR</strong></td>
<td></td>
</tr>
<tr>
<td>Water thin, slow set, solvent type. Also bonds other plastics to themselves. Non flammable.</td>
<td></td>
</tr>
<tr>
<td>0810451</td>
<td>4 oz.</td>
</tr>
<tr>
<td><strong>5 IPS ACRYLIC CLEAR</strong></td>
<td></td>
</tr>
<tr>
<td>Water thin, slow set, solvent type. Especially for Plex MC, Cyro</td>
<td></td>
</tr>
<tr>
<td>0810130</td>
<td>PT</td>
</tr>
<tr>
<td><strong>16 IPS ACRYLIC CLEAR</strong></td>
<td></td>
</tr>
<tr>
<td>Fast drying, high strength, thickened. Bonds acrylics to itself. Also for styrene, butyrate, polycarbonate and other plastics. Porous surfaces.</td>
<td></td>
</tr>
<tr>
<td>1106033</td>
<td>5 oz.</td>
</tr>
<tr>
<td><strong>35 IPS ACRYLIC CLEAR</strong></td>
<td></td>
</tr>
<tr>
<td>Light bodied, low viscosity, fast set. Especially formulated for continuous cast crosslinked acrylic. Also good for bonding dissimilar materials. Non-Flammable.</td>
<td></td>
</tr>
<tr>
<td>0811232</td>
<td>PT</td>
</tr>
<tr>
<td><strong>40 IPS ACRYLIC CLEAR</strong></td>
<td></td>
</tr>
<tr>
<td>0811350</td>
<td>4 oz.</td>
</tr>
<tr>
<td><strong>52 IPS MULTI-PURPOSE CLEAR</strong></td>
<td></td>
</tr>
<tr>
<td>Medium syrup. Multi-purpose for PVC, CPVC, ABS, styrene, Noryl, Sintra, etc.</td>
<td></td>
</tr>
<tr>
<td>0820640</td>
<td>PT</td>
</tr>
<tr>
<td><strong>1007 IPS VINYL CLEAR</strong></td>
<td></td>
</tr>
<tr>
<td>Thin syrup. Very fast set. Rigid bond. For rigid vinyl &amp; ABS.</td>
<td></td>
</tr>
<tr>
<td>0820232</td>
<td>PT</td>
</tr>
<tr>
<td><strong>2354 IPS ABS CLEAR</strong></td>
<td></td>
</tr>
<tr>
<td>0830232</td>
<td>PT</td>
</tr>
<tr>
<td><strong>1807 IPS STYRENE MILKY</strong></td>
<td></td>
</tr>
<tr>
<td>0835032</td>
<td>PT</td>
</tr>
</tbody>
</table>
Since polymerizable cements shrink as the cement hardens, the freshly poured cement bead should be left above the surfaces being cemented to compensate for the shrinkage. If it is necessary for appearances, the bead may be machined off after the cement has set, as shown in Figures 14(A and B) and 15.

Figures 16 and 17 illustrate two cementing techniques that have proven useful with the furnishings industry. The first shows a thick section butt joint using polymerizable cement, with the thick Acrylic sheet preset into a fixture. The latter Figure shows a system for making inside joints that cannot be routed and finished as described previously.

**Basic Cementing Techniques**

The two basic cementing techniques using unthickened cements are:

1. The capillary action method.
2. The soak or dip joint method.

The soak or dip joint method is not recommended for extruded acrylic sheet, because it dissolves rather than softens the sheet.

To use the capillary action method, the parts must be closely fitted, with no visible gaps. The parts to be cemented are either unclamped or very lightly clamped together. The cement is dispensed (from Craftics' Plasticator or syringe applicator) along the edge of the joint. Capillary action draws the cement between the parts. The time for the joint to set will vary from two to five minutes (sometimes longer), depending on the solvent used and temperature and humidity conditions. Figure 18 illustrates this method.

Do not flow or dip solvent cement on a flame-polished, strip heated or dry-belt sanded surface since these conditions show the maximum amount of fabrication stress possible in plastic sheet. With extruded acrylic sheet, use a minimum amount of solvent and pressure in the joint since it is more readily

---

**Craftics Plasticator for Solvent Cement**

Designed for edge bonding using the capillary method for applying solvent cement. Designed for easy replacement of clogged needle, rather than having to dispose of entire unit. Accomodates all needle sizes. **Metal needle openings range from 27 gauge for very thin solvent and 25 gauge for thin solvent to 16 gauge for thick solvents. Also available, 20 gauge poly needle for hard to reach places.**

<table>
<thead>
<tr>
<th>1/2 oz. Bottle</th>
<th>2 oz. Bottle</th>
</tr>
</thead>
<tbody>
<tr>
<td>1106536 16 Ga.</td>
<td>1106537 16 Ga.</td>
</tr>
<tr>
<td>1106051 20 Ga.</td>
<td>1106109 20 Ga.</td>
</tr>
<tr>
<td>Poly</td>
<td>Poly</td>
</tr>
</tbody>
</table>

**Craftics Universal Plasticator**

For application of any type of solvent, plasticator comes with set of interchangeable needles. Includes 1 each of the 27, 25, & 16 gauge (metal) and one 20 gauge (poly) needles.

<table>
<thead>
<tr>
<th>1106535 1/2 oz. bottle</th>
</tr>
</thead>
<tbody>
<tr>
<td>1106548 2 oz. bottle</td>
</tr>
</tbody>
</table>

**Replacement Needles (3 Pack)**

<table>
<thead>
<tr>
<th>1106017 27 Ga.</th>
<th>1106547 16 Ga.</th>
<th>1106546 Variety Pk.</th>
</tr>
</thead>
</table>
attacked by solvents, resulting in longer set times, lower joint strength, whitening in the joint and increased risk of crazing because the solvent takes longer to evaporate.

In the soak or dip method, the parts must also fit closely. One of the parts is placed in a container holding a solvent cement until the edge softens into a cushion. When the parts are assembled, the cushion from the first part forms a cushion on the other part by solvent action.

Masking may be required near the edges to be cemented, to prevent excessive softening. The parts should be allowed to set for 24 hours before handling. Figure 19 illustrates this method.

Cementing Acrylic Sheet to Other Materials

Before specifying cementing for attachment of Acrylic sheet to dissimilar materials, the possibilities of mechanical attachment should be carefully evaluated. Properly designed mechanical attachment overcomes the difficulties often encountered with cementing. For some applications, pressure-sensitive, double-faced tape may be suitable for joining Acrylic sheet to other materials.

Satisfactory joints between Acrylic sheet and other plastics and non-plastics are more difficult to make than Acrylic to Acrylic joints and usually give lower joint strength.

In most cases, there is a substantial difference in thermal expansion between Acrylic sheet and non-plastic materials. When joints between dissimilar materials are exposed to rising or falling temperatures, the materials expand and contract by different amounts, placing large stresses on any bond between them. Only cements that remain permanently flexible will continuously withstand these stresses.

When it is necessary to cement Acrylic sheet to non-plastics, the dimensions of the cemented areas should be as small as possible. This is especially true if acrylic is cemented to materials that have much smaller coefficients of thermal expansion than Acrylic sheet does.

If it is unnecessary for the joint to be transparent, many adhesives, such as silicones, polysulfides, and rubber base adhesives, are available. Most of these adhesives are suitable for outdoor applications.

ANNEALING ACRYLIC SHEET
Health and Safety Precautions

Annealing Acrylic sheet should not result in the release of harmful concentrations of vapors or gases under the annealing conditions recommended in this manual. However, Acrylic sheet may release high concentrations of vapors and monomers if heated to temperatures in excess of 350°F without adequate ventilation.

The annealing oven should have forced-circulation and should have bleed and makeup vents, so that the air is changed at least twice an hour to remove fumes and cement-solvent vapors. Fumes and cement-solvent vapors should be exhausted to the outdoors. Parts should be heated to and held at the recommended annealing temperatures for the recommended times. (See Table 8, page 38)

Acrylic sheet is a combustible thermoplastic material. Observe fire precautions appropriate for comparable forms of wood and paper products.

Annealing

Proper annealing is one of the most effective single measures that can be taken to insure good service from parts made of Acrylic sheet.

Annealing consists of prolonged heating of the acrylic part at temperatures lower than those used for forming, followed by slow cooling. Internal stresses set up during fabrication of the article are reduced or eliminated by this treatment. All edges should be cut or machined with as little internal stress as possible. If excessive internal stress is present in the parts to be cemented, crazing will occur during the cementing process. It may be necessary to anneal the parts to reduce internal stresses set up in the parts during fabrication or thermoforming operations. Annealing results in greater dimensional stability and greater resistance to crazing. Heat treating also improves the strength of certain cemented joints. (See Graph 1, page 28)
### TABLE 8: Recommended Annealing Times and Temperatures for Acrylic Sheet

<table>
<thead>
<tr>
<th>Maximum Thickness (Inches)</th>
<th>Time* (Hours) to Heat Mid-Plane</th>
<th>Heating Time (Hours) in Forced Circulating Air Ovens Maintained at the Indicated Temperature for Parts Made of Acrylic</th>
</tr>
</thead>
<tbody>
<tr>
<td>.060 - .177</td>
<td>1/2</td>
<td>1-1/2, 3-1/2, 7-1/2, 24-1/2</td>
</tr>
<tr>
<td>.236 - .354</td>
<td>1</td>
<td>2, 4, 8, 10, 25</td>
</tr>
<tr>
<td>.472 - .708</td>
<td>2</td>
<td>3, 5, 9, 26</td>
</tr>
<tr>
<td>.944</td>
<td>3</td>
<td>4, 6, 10, 27</td>
</tr>
<tr>
<td>1.5 - 1.75</td>
<td>6</td>
<td>7, 9, 13, 30</td>
</tr>
<tr>
<td>2.0</td>
<td>8</td>
<td>9, 11, 15, 32</td>
</tr>
</tbody>
</table>

* The time required to raise the temperature of the mid-plane to a temperature equal to room temperature plus 99% of the difference between room temperature and annealing temperature.

Notes: (1) Anneal parts at the highest temperature for indicated time. If distortion occurs, try the next lowest temperature. (2) The cycles given will be satisfactory for most formed parts. For extreme forming, such as 100% biaxial stretching, use lower temperatures. (3) Air should circulate around each part.

To obtain the benefits of annealing, the Acrylic sheet parts must be annealed after all fabrication steps, including polishing, are completed. In addition to annealing after final finishing, machined parts should be annealed before cementing to reduce stress due to machining in the cement joint area.

### Determination of Best Annealing Temperature

The optimum temperature for annealing any specific part can best be determined by experimenting with a few samples to find the maximum temperature at which the part can be heated for the times indicated in Table 8 without objectionable deformation. Parts should be annealed at as high a temperature as possible. Annealing at temperatures lower than those listed in Table 8 will not give effective relief and redistribution of stresses. Machined Acrylic sheet parts that have not been heated to forming temperature should be annealed with caution in the higher temperature ranges.

The annealing temperature should be approximately 10°F below the minimum temperature at which the part shows deformation of 1%. A greater change indicates that the part has not been properly formed.

The fabrication process should be carefully reviewed and revised until the parts will withstand these annealing temperatures. Particular attention should be given to forming temperatures and conditions because parts allowed to cool too much before forming is completed, tend to relax at lower annealing temperatures.

In addition to increased dimensional stability and resistance to crazing, annealing increases the strength of certain cemented joints.

Annealing also lessens the effect of solvent smears and "runs" which may result from errors in cementing. Proper annealing will eliminate any tendency toward immediate crazing or cracking of parts subjected to brief exposure to solvents; e.g., parts which are to be painted. If the solvent makes the Acrylic sheet sensitive to crazing as do some types of paints, the parts should be annealed after each exposure.

When only surface stresses are present, only the surface needs to be heated. This will greatly reduce annealing times for thick parts.

Drilled holes may be considered a special case.
**TABLE 9: Cooling Times for Acrylic Sheet**

<table>
<thead>
<tr>
<th>Maximum Thickness (Inches)</th>
<th>Cooling Rate (°F/Hr.)</th>
<th>Time (Hours) to Cool Acrylic Sheet Parts from the Indicated Temperatures to 120°F.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>230°F (110°C)</td>
</tr>
<tr>
<td>0.060 - 0.177</td>
<td>140</td>
<td>3/4</td>
</tr>
<tr>
<td>0.236 - 0.354</td>
<td>54</td>
<td>2</td>
</tr>
<tr>
<td>0.472 - 0.708</td>
<td>25</td>
<td>4-1/2</td>
</tr>
<tr>
<td>0.944</td>
<td>18</td>
<td>6</td>
</tr>
<tr>
<td>1.5 - 1.75</td>
<td>12</td>
<td>9</td>
</tr>
<tr>
<td>2.0</td>
<td>10</td>
<td>11</td>
</tr>
</tbody>
</table>

Notes: (1) Parts are usually held in the forced circulation air oven and the temperature of the oven dropped at the cooling rate. (2) As in heating, the air should circulate around each part.

of surface machining. Parts with through holes must be placed in the oven so that the air flow is along the hole passage.

Caution: Protective spray masking coatings must be removed from Acrylic sheet parts before they are annealed. If such coatings are not removed prior to annealing, optical distortions may appear in the annealed part in areas where the thickness or surface of the coating is irregular.

**Annealing Procedures**

Acrylic sheet parts to be annealed should be clean and dry and should be supported so that they are not under stress while being annealed. This is particularly true when clamps are used to hold cemented assemblies together during the annealing or curing period. The weight of the clamps or excessive clamping pressure may set up local stresses which may warp or even craze the parts unless proper precautions are taken.

Room should be provided between parts to permit free circulation of air. This will avoid traps or pockets of dead air where solvent vapors can settle.

**Slow Cooling After Annealing**

The rate of cooling must be slower for thick sections than for thin sections. Table 9 lists suitable cooling rates for various thicknesses of Acrylic sheet.

Annealing cycles can be worked out in many ways. Some fabricators allow their forming ovens to cool to annealing temperature near the close of the day's work, place the fabricated parts in the oven and hold them at the annealing temperature for the specified time, then adjust the oven to cool during the night at the specified cooling rate.

**MAINTENANCE OF ACRYLIC SHEET**

**Dusting**

Always damp-dust Acrylic sheet.

**Cleaning**

Use a clean, dry, lint-free, absorbent, non-abrasive cloth such as Craftics Wipes. Do not use rayon or polyester cloths which can scratch the plastic.

Use a liberal amount of Craftics 20/20 Plasti-Cleaner and rub in a circular motion until all of the cleaner is absorbed by the cloth. 20/20 Plasti-Cleaner provides extra protection against dust and fingerprints with its anti-static ingredient. For the ultimate in anti-stat and where a shiny surface is desired use 20/20 Plus Plasti-Cleaner.
Do not use window cleaning fluids, scouring compounds, leaded or ethyl gasolines, benzene, acetone, carbon tetrachloride, fire extinguisher or de-icing fluid, lacquer thinners, or other strong solvents. To remove tar, grease, paint, etc., use a good grade of VM & P naphtha, kerosene, or other aliphatic hydrocarbon compound.

Polishing
If, after washing, the Acrylic sheet surface shows minor scratches, most can be removed or reduced by application of polish. Use Crafts 20/20 Plasti-Polish for the removal of scratches. First apply to a small area to test results before using over entire area. Use a liberal amount of polish and rub in a circular motion and let dry to a haze. Then wipe haze off with clean dry cloth (much like polishing a car). For badly scratched areas, you may have to make several applications. When making multiple applications of polish, use 20/20 Plasti-Cleaner or 20/20 Plus Plasti-Cleaner between every 2 polish applications for best results.

**INSTALLATION OF WINDOWS**

Recommended Thicknesses:
For windows up to 24” x 36” — 1/8” thick
From 24” x 36” to 36” x 48” — 3/16” thick
From 36” x 48” to 48” x 72” — 1/4” thick

**EXPANSION ALLOWANCES**

<table>
<thead>
<tr>
<th>For window sash size:</th>
<th>Cut Acrylic shorter than opening by:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 24” x 24”</td>
<td>1/8” in width &amp; length</td>
</tr>
<tr>
<td>Up to 24” x 48”</td>
<td>1/8” in width &amp; 3/16” in length</td>
</tr>
<tr>
<td>Up to 36” x 72”</td>
<td>3/16” in width &amp; 1/4” in length</td>
</tr>
</tbody>
</table>

**RABBET DEPTHS**

<table>
<thead>
<tr>
<th>For window sash size:</th>
<th>Rabbet Depth (Width of Frame):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 24” x 36”</td>
<td>1/2” to 5/8”</td>
</tr>
<tr>
<td>Up to 36” x 48”</td>
<td>5/8” to 3/4”</td>
</tr>
<tr>
<td>Up to 48” x 72”</td>
<td>7/8” to 1”</td>
</tr>
</tbody>
</table>

**Caulking**
For windows of Acrylic under 24” in length you may use any non-hardening glazing compound. For windows over 24” a continuous removable stop with a polysulfide sealant or butyl tape must be used.

**Mounting Holes**
Acrylic windows should be installed in frames and held in place with clips or with a continuous metal or wood bead. Because plastics expand and contract 10 times as much as glass, we do not recommend the bolting of windows or signs to a frame. However, if it is absolutely necessary to fasten a small or medium size panel with screws, the mounting holes must be large enough to allow for expansion and contraction.

For example: If you install a 4-foot sheet with 3/16” dia. screws, all holes must be at least 3/8” dia. For indoor applications the holes can be 5/16” dia. Long, narrow panels can have slots instead of oversize holes.

Do not use flat head (countersunk) screws. You must use round head screws and a large washer, preferably a stainless steel washer with a rubber washer underneath. The screws should be backed off half a turn after tightening, to allow the sheet to expand and also to avoid local stresses.

**Cleaning of New Glazing**
If Acrylic is to be installed in window sash, the masking paper should be removed just prior to the installation.

As an alternate method, instead of removing the masking paper entirely, you can roll it back approx. 1” to 2” along all edges.

This will protect the surface of Acrylic from glazing compound and sealant smears.
**CRAFTICS 20/20 PLASTI-CLEANER**
Specially formulated to clean acrylic and other hard plastic surfaces without scratching, hazing or harming the plastic surface. Also contains anti-static to resist fingerprints and dust. 20/20 Plasti-Cleaner and 20/20 Plus have been tested in accordance with the Good Laboratory Practice Standards as described by the FDA (21 CFR Part 58) and are certified non-toxic, not an eye irritant, and not a skin irritant.

- 1106011  8 oz. Squirt
- 1106021  8 oz. Pump
- 1106000  24 oz. Spray
- 1106018  1 Gal.
- 1106071  5 Gal.

**CRAFTICS 20/20 PLUS PLASTI-CLEANER**
Same powerful cleaning formula but has added silicone for superior anti-stat and shinier surfaces.

- 1106023  8 oz. Squirt
- 1106024  8 oz. Pump
- 1106025  24 oz. Spray
- 1106008  1 Gal.

**CRAFTICS 20/20 PLASTI-POLISH**
Specially formulated for the removal of fine scratches, haziness and abrasions from most plastic surfaces. After polishing, use 20/20 Plasti-Cleaner or 20/20 Plus Plasti-Cleaner to restore surface to bright shiny appearance.

- 1106377  8 oz. Squirt
- 1106383  1 Gal.

**CRAFTICS WIPES**
New disposable soft cloths for use with 20/20 Plasti-Cleaner or 20/20 Plasti-Polish to insure no lint or scratches. Package includes 3 wipes in poly bag with self hanging header. Wipes are 15" x 16". Stock No. 1106533.

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After you have applied the glazing compound, you must immediately remove the masking paper. If masking paper is exposed to the sun, the adhesive will harden. After a few days of such exposure, it will be impossible to remove the masking paper.

Glazing compound and residue of masking paper adhesive should be removed with a soft clean cloth dampened with isopropyl alcohol. The remaining film can be washed off with soap and water.

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**STORAGE AND HANDLING**
Acrylic sheet is shipped in corrugated fiber cartons or in wood-reinforced fiberboard boxes having a gross weight of 400 pounds or more or on pallets weighing approximately 2,000 pounds. All cast and extruded acrylic sheets are boxed in standard packages. The number of sheets in each package depends on the size and thickness of the sheets.

Containers should be handled carefully to prevent damage to the Acrylic sheet. When possible, forklift trucks should be used to move containers. Otherwise a special hand truck can be constructed or purchased to facilitate safe
and economical handling of cases of Acrylic sheet.

Storage areas should be well ventilated. Air should circulate freely and should be relatively moist and cool. The temperature should not exceed 125°F. If Acrylic sheet is stored in a hot, dry environment or for extremely long periods of time indoors, the adhesive on the masking paper may eventually dry out, making it difficult to remove. Excessive moisture may cause the paper to deteriorate and reduce its effectiveness for protecting the plastic.

Storage areas for Acrylic sheet should be completely separated from spray painting booths and other possible sources of solvent vapors which may attack and soften the surface of the material.

Packages of Acrylic sheet should be stored on edge at a 10 degree angle from the vertical. Two-by-three inch wood strips placed on the floor about 42 inches apart will keep package edges off the floor and facilitate handling with forklifts or hand trucks.

Formed sections of Acrylic sheet must be stored in relatively cool areas. If the parts are to be stacked, they must not be nested, but should be placed in simple frames or racks that fully support the parts so that they will not deform.

Masked Sheets

Most acrylic sheets are supplied with a tough Kraft masking paper on both sides. The paper is coated with a pressure-sensitive adhesive that does not attack the Acrylic sheet surface. Extruded acrylic sheet may also be purchased with a heavy-duty polyethylene masking. The polyethylene clings tightly to the surface without adhesive, so it is easier to remove than paper, and makes the sheet easy to fabricate.

The masking helps prevent accidental scratching during normal handling and fabrication operations, and should be kept in place for most cutting and machining procedures. Although the masking provides a significant degree of protection against surface marring, the fabricator should avoid sliding the sheets over each other or across rough or soiled surfaces.

Paper masking should be removed from both sides of the sheet before it is thermoformed or stored outdoors.

Masked pieces of Acrylic sheet are best stored on edge in A-frame storage racks. Typically these racks are constructed of plywood and slotted angle iron. The supporting floor of each partition is 1/2 inch thick plywood. The floor panel may be covered with galvanized sheet metal for increased wear resistance. The rack's A shape equalizes the weight and eliminates stresses on building walls.

These racks give full support to the sheets yet permit easy removal of individual sheets from any rack.

If masked sheets must be stored flat, avoid trapping chips and dirt between the sheets. Such chips and dirt may scratch or press into the surface of the material. Acrylic sheet should not be piled more than 18 inches high. Small sheets should be stacked on top of the larger ones to prevent unsupported overhang.

It is good practice to store sheets of similar formulation, color, and thickness together. Mark this and other pertinent information on the masking of sheets that have been cut so they can be identified when needed.

The adhesion of masking paper on the Acrylic sheet may increase over time, making it difficult to unmask. Use older stock first. Newly received sheets should be placed behind the older sheets in the storage bins.

Masked Acrylic sheet should never be stored outdoors or even for extremely long periods of time indoors. Exposure to sunlight and weathering longer than a few days makes removal of masking paper very difficult. If it is absolutely necessary to store Acrylic sheet outdoors, remove the masking paper and cover the sheet with a suitable tape or protective coating.

The masking paper used on Acrylic sheet is not water repellent. If masked Acrylic sheet is soaked with water, a white residue may be left on the material when the masking paper is removed. To avoid this, store masked sheet where it cannot come into contact with water. If a residue is deposited on the Acrylic sheet, it may be removed by wiping the surface gently with a clean, soft, damp cloth and drying it with a soft flannel cloth.
Unmasking

Acrylic sheet can be unmasked by lifting the masking paper along one edge and rolling it around a dowel or cardboard tube. The paper may be built up on the dowel or tube in successive layers using the adhesive layer to secure the turned up edge of the masking to the paper-covered dowel. Remove all residual adhesive from the sheet surface at the time of masking removal. Any residue that remains can be cleaned off by wiping with a soft clean cloth dampened with isopropyl alcohol.

Un masking usually builds an electrostatic charge on the Acrylic sheet. The electrostatic charge attracts dust and lint to the acrylic surface. Eliminate the charge by wiping the sheet with a dampened cloth or clean with 20/20 Plasti-Cleaner after unmasking. During dry weather, wet down the shop floor occasionally to minimize dust.

For operations such as strip heating, cementing, or applying glazing sealants, only the masking paper in the area being worked on should be removed from the sheet. When cutting out small sections of masking paper, take care not to score or scratch the Acrylic sheet surface underneath. Scoring the sheet may reduce its impact resistance.

Special tools can be employed to minimize the possibility of scoring or scratching the Acrylic sheet when removing small masking sections. When used properly in combination with a suitable solvent, these tools will not score or scratch the sheet.

Masking paper may be difficult to remove in the following circumstances: 1) Acrylic sheet that has been stored outdoors and exposed to sun and moisture; and 2) sheet that has been stored indoors for lengthy periods or has been exposed to heat or high humidity. When the sheet will be thermoformed, and the masking paper is not adhering too tightly, flash heating the sheet for 60 seconds at 350°F. will loosen the paper enough for easy stripping.

In cases where the paper is sticking more tenaciously, it may be necessary to use Craftics Mask Off to loosen the masking paper. In such cases, thoroughly soak the masking paper with the Mask Off, and allow at least 10 minutes for the Mask Off to penetrate the paper. Strip as described above. If necessary, apply more Mask Off along the separation line between the masking paper and the Acrylic sheet.

Remove the Mask Off from the Acrylic sheet as soon as possible by first washing the sheet with isopropyl alcohol, then with soap and water and, finally, with clear water.

Before attempting to remove tightly adhering masking with Mask Off, become familiar with the properties of Mask Off and take proper safety precautions. Obtain Material Safety Data Sheets from the manufacturer. Ventilate the work areas as OSHA requires, and prohibit smoking or open flame.

Unmasked pieces of Acrylic sheet should be stored in the original shipping cases. Full cases can be stored on edge. Open cases can be stored flat or they can be placed on edge in roller-type racks. Uncased sheets may be stored in A-frame racks. The interleaving tissues should not be removed until the sheets are used.

Remasking

The masking paper used on Acrylic sheet will retain its tack and may be replaced if desired. Film masking cannot be reapplied. The adhesive bonds firmly to itself, however, so the coated sides of the masking paper must not be allowed to contact each other. The masking paper can be rolled up in loose tubes and stored on pegs in a clean, dry area. Take care to avoid contaminating the masking paper with dirt to keep from scratching the Acrylic sheet when the masking paper is reapplied.

Prepared masking papers are available from a number of sources and may be used for remasking. Before using one of these products,
however, check its adhesive to be sure it will not attack the Acrylic sheet.

**Protective Coatings**

Masking compounds are available that can be sprayed on the Acrylic sheet and later peeled off. These are especially useful when remasking formed parts.

The spray masking compounds should not have a harmful chemical action on the Acrylic sheet. Some masking compounds may be used indoors for periods as long as 12 months. In general, no masking compound should be used on parts that will be stored outdoors for more than two months.

When using spray masking compounds, apply a coating at least 3-5 mils thick. If the film is too thin, it may be difficult to remove. The film should also be uniform and free from runs and other imperfections.

To remove spray masking from Acrylic sheet, peel it off or lift a corner of the film and blow a jet of compressed air under it. If the film is hard to remove because it was applied too thinly, apply a fresh coating of the masking compound, let it dry, then remove it. In some cases, it might be necessary to apply a layer of cheesecloth over the fresh spray coating and let it dry before attempting removal. The cheesecloth reinforces the spray coating and makes it easier to remove.

If the protective film has deteriorated because it has been stored outdoors, soaking the coated part in cold water for 24 to 48 hours may help to soften the film. Stripping compounds supplied by the manufacturers of the spray masking compounds may also be used if they will not craze the Acrylic sheet.

Remove protective spray masking coatings from Acrylic sheet parts before the parts are annealed. Otherwise, optical distortions may occur in areas where the thickness or surface of the coating is irregular.

The manufacturers of the protective spray masking should provide the precautions necessary for the safe usage of their products.

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**Crafties®**

Tools and Accessories for working with Plastic

**Plastic Cutting Router Bits**

**POLYCARBONATE CUTTING ROUTER BITS**

High speed steel bits specially designed for cutting polycarbonate and provide a superior finish.

<table>
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<tr>
<th>Stock No.</th>
<th>Cutting Edge Dia.</th>
<th>Cutting Edge Length</th>
<th>Shank Dia.</th>
<th>Overall Length</th>
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<td>11-05</td>
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<td>3/4&quot;</td>
<td>1/4&quot;</td>
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<td>11-02</td>
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<td>1/4&quot;</td>
<td>2-1/8&quot;</td>
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**ACRYLIC CUTTING ROUTER BITS**

Carbide or Carbide tipped bits specially designed for cutting acrylic and provide a superior finish.

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<th>Shank Dia.</th>
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<tr>
<td>48-654</td>
<td>1/4&quot;</td>
<td>1&quot;</td>
<td>1/4&quot;</td>
<td>2-3/8&quot;</td>
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FASCINATING FABRICATING

The following articles are reprinted with permission from the Plastics Distributor & Fabricator Magazine. The articles were written by Mr. Arvin Meyer. He has 25 years experience in fabricating wood, metal and plastic.

Cementing Thin Stock

One problem that frequently occurs is solvent gluing small quantities of thin stock. The problem compounds itself as the sheets become larger and larger, due to buckling. As a result, more time is usually spent preparing the holding fixtures, than actually assembling the joints.

This problem can be easily solved by the use of various tape products including double-faced carpet tape, duct tape and masking tape. Residues can be removed with mineral spirits or Naptha. Of course, it is important that you make sure that your choice of solvents for tape residue removal won’t adversely affect either the material with which you are working, or the joint itself.

The illustrations below also show a right-angled holding fixture which can be made of wood, plywood, or suitable sheet scrap. These fixtures are suitable for welding or solvent gluing. Care must be taken with prudent use of solvent-based glue to avoid wicking under the tape and possibly ruining the surfaces.

Cementing Thick Sheet

From time to time I get questions from my clients about how to go about solving various gluing problems. It seems as if gluing thick sheets poses greater difficulty than almost any other procedure. Possibly, the reason is due to the fact that most fabricators glue thicker sheets with less regularity than thinner stock, say 1/4 inch or less.

Most of the problems occur because of faster solvents being used to adhere thick stock. These problems include blushing, bubbles in the joint, poor adhesion, and voids in the joint. Let’s start with blushing. Blushing occurs solely because the solvent evaporates too quickly. The fast evaporation causes the air near the joint to drop in temperature below the dew point. This occurs in humid climates, such as Florida’s, more frequently than in the more arid climates of Arizona, and the southwest. It also occurs more frequently in summer when the humidity levels are higher. This problem can be solved either by changing solvents to a slower evaporating one, or by adding some Acetic acid to the solvent you are now using to slow down its evaporation rate.

Try adding about 5% Acetic acid to the solvent. In the summer, you might also try gluing in an air conditioned or dehumidified environment.

Bubbles, poor adhesion, and voids in joints, especially in stock 1/2” thick and thicker, are generally caused by joints which are not truly flat. A major cause of the problem is the stock itself. Cast acrylic is inherently not truly flat. It is normally cast upon a glass mold which is in and of itself not flat. Fabricators tend to compound the problem by using woodworking jointers to straighten and finish the edges to be glued. Not good enough...dedicated edge finishing machinery will prepare an edge properly for gluing.
This is especially important when gluing thicker stock. Another solution is to soften the edge thoroughly by immersing approximately 1/32” of it in solvent for a period of 5 to 30 minutes depending on the speed of your solvent, and the thickness of your material. A right-angle vacuum jig such as the one shown below can be used to hold the workpiece securely. If you don’t already own a vacuum pump, a very inexpensive one which will operate from your air compressor, can be obtained from Quality Vakuum Products, Inc. An edge which is softened in this manner will very often mold itself to the slight irregularities in the face of the sheet.

The right-angle jig shown below can be made of thick scrap pieces. The one pictured was made from 3/4” acrylic approximately 8” x 10” to a face. The angled gussets should be cut very square, as they insure that the jig itself will not be pulled out of alignment when the vacuum is applied. For those of you who are unfamiliar with the power of a vacuum to hold, a 28” vacuum will hold at a rate of about 14 lbs./sq. in., on the jig below that is approximately 900 pounds of holding force on each face. As a matter of fact it is possible that the jig itself can throw the faces out of flatness; the remedy for that being to apply additional pieces of vacuum gasket tape on the interior portion of the jig face so that it is pulled evenly. One jig is sufficient to glue about 24” of edge to a face; for longer edges use more jigs. Make sure that you use separate valves to apply the vacuum to each face of the jig, as it is impossible to move the jig for realignment once a vacuum is applied.
Edge Gluing Two Pieces

Occasionally, it becomes necessary to edge-glue two pieces together - either to change colors, thicknesses, or sizes. It is always a real problem to align the surfaces and put just the right amount of pressure on the glue joint. The jig that I am about to describe will, if accurately built, assure alignment within a few thousandths of an inch. You will be able to put any amount of pressure you wish on a joint with an accuracy level of about 5 pounds. The engineering principles behind the operation of this jig can be used to build all types of jigs and fixtures, some of which I will outline in future articles.

Two technologies are used in this jig - air pressure and vacuum. It is the combination of the two which allows control of both alignment and clamp pressure. Careful machining of the parts will insure the accuracy essential to the perfect edge matching of the two pieces.

As you can see in Figure 1, the devise consists of two flat pieces of acrylic upon which two air cylinders are mounted. It is important that the acrylic is flat and true in thickness because the alignment of the pieces to be glued depends upon it. The 3 cross bars are glued on the right acrylic piece and slide on the left one as shown in figure 2. The 18" dimension of the support bars will be sufficient to edge glue sheets from 18" to about 24", however, if you have thin stock, make the support bars no more than 2" shorter than the stock you are gluing. Wider stock needs longer support bars.

![Figure 2](image)

It is important that the slide fit tight enough to have no vertical travel or the edges will not align properly. The fit should, however, be loose enough so that you don't have to use any pressure to push the pieces together. Adjust the fit with shims if necessary.

The third and final view shows the placement of the vacuum port and gasket tape on the bottoms of both pieces. In use adjust the vacuum level to at least 10" of mercury or enough to hold the pieces in alignment securely but without any deflection.

![Figure 3](image)

Find the minimum air cylinder pressure necessary to bring the parts together, then add about 10 psi. On a 1" air cylinder that should give you 18 to 20 pounds of clamp pressure; which is usually sufficient to clamp sheets together without over stressing the joint. Use more pressure if needed, but be careful not to distort the joint.

With this fixture you can glue thick sheet stock, leaving just enough space to use any glue system you wish and put just the right amount of pressure on the joint, immediately. All it takes is a throw of a valve.
CRAFTICS FABRICATION ACCESSORIES

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The strongest clear acrylic hinge. Designed to work on 1/4", 3/16" and 1/8" materials. Acryl-Hinge 2 has an optical finish, self lubricating transparent nylon pin, large cementing areas, reinforcing ribs, and Magic Bumps for perfect bonds every time. Size: 1-1/2" x 1-3/4". P/N 1106072

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Crystal clear acrylic pulls, injection molded, ready to cement for the ultimate in convenience and look. Less labor - less cost! Three sizes, each suitable for a variety of applications.
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- 1106049 7/16" x 2-3/4"
- 1106052 1/2" x 3-1/2"

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Solvent cementable clear continuous piano style hinge.
- 1106382 12"
- 1106434 16"

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1/8" round clear hooks are unbreakable molded polyester, perfect for any type of display. Sold in Bulk Only.
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- 1106113 1-1/4" 1/2"
- 1106114 1-1/2" 5/8"
- 1106115 1-3/4" 5/8"
- 1106116 2" 5/8"

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- 1106103 4.25" Dia
- 1106104 5.5" Dia
- 1106105 9" Dia
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