

PolyOne Designed Structures and Solutions, LLC.

70 Carlisle Place  
Stamford, Connecticut 06902-7614  
Phone +1 203.327.6010  
Fax : +1 203.323.2925

<http://DSS.polyone.com/polycast>

## TECHNICAL BULLETIN

### ***POLYONE SAR™ FABRICATION, CLEANING, AND REPAIR***

Since its revolutionary introduction PolyOne SAR™ has had more than 30 years of successful market applications. This generation has the PolyOne name of quality, service and performance behind it.

#### **Introduction**

PolyOne SAR Super-Abrasion-Resistant acrylic sheet can be easily fabricated using techniques currently practiced in the plastics industry. Parts made from POLYONE SAR sheet can be machined, drilled, threaded and routed with standard wood and metal working equipment. This bulletin provides information on POLYONE SAR fabrication, cleaning and repair techniques.

#### **Masking**

To provide protection during shipping, handling and storage, SAR sheets are covered with a tough masking paper that is secured with flexible adhesive. It is convenient for penciling in guidelines for sawing, drilling and other machining operations. Masking should be kept on the sheet through as many of the processing stages as possible. Masking paper must, however, be removed before heating and forming operations are started.

To remove the masking paper, loosen one corner with a fingernail, then either peel back the paper with a slow and steady pull, or roll the paper off on a tubular support. Because the pressure-sensitive adhesive on the masking paper retains its tackiness for several applications, you can use this paper to re-mask SAR sheet. If you plan to use the masking paper again, make sure it is rolled as a tube and kept clean. If adhesive particles remain adhered to the sheet after you remove the paper, you can remove them by dabbing them with a wad of masking paper or by wiping the sheet with a soft, grit-free cloth that contains naphtha or isopropanol.

**CAUTION:** Both naphtha and isopropanol are very flammable, have relatively low flash points and are easily ignited. Use in a well-vented area.

#### **Storing**

POLYONE SAR may be stored horizontally or stacked vertically in racks. Stacking sheets vertically in racks eliminates the possibility that hard particles, such as sharp-edged pieces of plastics, metal chips, sand or cinder will become lodged between the sheets. When stacked horizontally, the pressure of the sheets will force such particles into the plastic.

Consider the following when storing POLYONE SAR acrylic sheet:

- If you stack sheets vertically in racks, be sure to support them adequately to prevent bowing.

- Avoid storing sheets with paper masking in areas where the temperature is 125°F or higher.
- Do not store in areas where intense sunlight is present. Intense sunlight can bake the masking paper on the sheet.
- Do not store in areas where damp and/or water flooded conditions exist. This may cause the sheet to warp and/or absorb water.

#### **Safety**

Safety goggles, gloves and other protective clothing should be worn when cutting, routing, drilling, threading or tapping POLYONE SAR acrylic sheet.

#### **Machining Rules**

POLYONE SAR sheet can be machined in much the same manner as wood or soft metals such as brass. It can be handworked and cut with files, scrapers and hacksaws. The following general rules should be applied when machining POLYONE SAR acrylic sheet.

- Keep tools sharp. Eliminate nicks and burrs from all cutting areas. Cutting tools and the acrylic pieces should always be supported firmly to prevent chattering and chipping. Ragged or chipped areas create notches where fracture or crazing can easily occur.
- Hard, wear-resistant tools, such as those with tungsten tips, are preferred because they retain their sharpness longer and provide better-machined finishes.
- In general, when cutting POLYONE SAR, use cutting tools that have a scraping rather than shearing action.
- To produce satisfactory work, it is very important to keep your machine and materials clean. It is usually desirable to protect the SAR sheet surface with masking paper during machining operations. Working areas should be kept free of sawdust, dirt and chips that can scratch the sheet. Use compressed air or vacuum to remove any particles that could scratch the sheet. Tables with a smooth, hard surface like "Formica" are easy to keep clean and provide good working surfaces.
- Since plastics have much lower thermal conductivity values than metals, thermoplastics tend to soften if excessive heat is generated during machining. Therefore, a coolant or a blast of air is sometimes required to dissipate the heat from the acrylic piece during machine operations.

## Layout

Pencil cutting lines directly on masking paper or mark them on the surface of unmasked acrylic sheets with a chine-marking pencil. For close tolerances, use a cutting scribe or razor blade to outline the work directly on the surface of the sheet.

When many identical pieces are to be cut out, use templates made of plastic, wood or metal to guide the scribe. Remove masking paper from a surface before you scribe it. Replace the masking paper ¼ in. (0.635 cm) from the scribed markings prior to cutting.

Keep cutting blades clean and sharp. A blade in continual use often accumulates a residue, which may cause chipping, binding and a whipping action during sawing. Cutting blades should be cleaned at the end of each day or at the end of each long run. Strong solvents for acrylic resins such as acetone or toluene can be used to clean the blades. Cutting blades and mandrels should always be kept free of any play or wobble. Using a lubricant such as soap and water or mineral oil or a coolant such as a blend of one part Johnson M-54 (S.C. Johnson & Son, Inc., Racine, WI 53403) in forty parts water, will help to dissipate frictional heat, extend blade life and reduce the tendency of the acrylic to gum up along the blade edge. Applying masking tape over the area to be cut will reduce the tendency of the acrylic sheet edge to chip during cutting.

## Straight-Line Cutting with Circular Saws

Circular saws used to cut POLYONE SAR acrylic sheet should be hollow-ground to aid cooling and prevent binding. Expansion slots should be present in the rim of the saw to prevent heat warping and blade whipping. Carbide-tipped blades will produce a superior cut and provide a longer life between sharpening than will steel blades. Circular saws should be run at relatively high speeds of about 8,000 to 12,000 linear feet per minute (2,440 to 3,660 m/min.)

The acrylic sheet should be fed slowly enough to prevent overheating by friction with the blade. The use of a lubricant or a coolant will permit the plastic to be cut at a faster rate without overheating. A lubricant will also reduce the danger of chipping, produce cleaner cuts, help overcome the tendency of the saw blade to bind or stick, extend the life of the saw blade and reduce the amount of "smoking." Water is a satisfactory lubricant for cutting acrylic sheet. If equipment corrosion is a factor, water-soluble oil can be used as a coolant. Bar soap may also be used as a lubricant. When several pieces are cut simultaneously, oiled paper may be placed between the SAR sheets to supply lubrication. The thicker the material is being cut the larger the blade diameter and the fewer the number of teeth per inch that are required.

Use Table I as a guide to help you select the proper circular saw blade to cut various thickness of POLYONE SAR acrylic sheet.

**TABLE I**  
**Circular Saw Blade Selection**

Inch	(mm)	Sheet Thickness		Blade Thickness (2.54cm)
		Teeth per Inch	(mm)	
0.080-0.150	(2.0-3.8)	3/32	(2.4)	6-8
0.150-0.375	(3.8-9.5)	3/32	(2.4)	5-6
0.375-0.750	(9.5-19.0)	1/8	(3.2)	3-4
0.750-1.500	(19.0-101.6)	5/32	(4.0)	3-3.5

All the teeth should have uniform height, the same shape, triple chip grind, a uniform hook or "rake" between 0o and 8o to avoid chipping and a slight set to give clearance of 0.010 to 0.015 inches (0.254 mm to 0.375 mm). An 8-inch (20.3 cm) diameter blade is suggested for lighter work; while a 12-inch (30.5 cm) diameter heavy gauge blade should be used for heavier work. A large-diameter blade provides a greater cooling surface and a thicker blade will conduct away more surface frictional heat.

The circular saw blade should be set at a height slightly greater than the thickness of the section to be cut. The acrylic piece should be held firmly and moved in a straight line parallel with the saw blade to prevent chipping. A separator blade directly behind the saw blade can be used to prevent the kerf from closing on or reknitting the cut edge. Using a sliding jig that provides an even and steady feed of the acrylic sheets will result in smoother cuts and longer blade life.

**IMPORTANT:** To avoid chipping at the corners, reduce the feed rate as the blade enters or leaves the cut acrylic piece.

When cutting masked sheet, the adhesive can build up between adjacent teeth of the saw blade. This gumming of the blade can be reduced by applying a small amount of lubricant to the blade.

Traveling saws are suggested for cutting stacks of POLYONE SAR acrylic sheet or for making straight cuts longer than three feet. The plastic remains stationary, positioned with a hold-down bar to prevent chattering while the saw is power-driven or is hand-cranked through the acrylic sheet at a rate of 10-25 ft./min. (3-7.6m/min.)

## Curved Line Cutting with Band Saws

Band saws are used for cutting curves in flat acrylic sheet, for trimming formed parts, and for cutting thick sections of stacked acrylic sheets. Variable speed band saws that can run at 5,000 ft./min. (1,524m/min.) and have a 28 to 36 inch (71 to 79 cm) throat are best suited for production work.

Metal-cutting blades are generally the best types for cutting acrylic sheet. The selection of the blade width, blade thickness and the number of teeth depend on the radius and the thickness of the acrylic sheet to be cut. Use Table II as a guide for selecting a band saw blade to cut acrylic sheet.

**TABLE II**

**Band Saw Blade Selection**

Minimum Radius To be Cut		Blade Width		Blade Thickness		Teeth per Inch (2.54 cm)
Inch	(mm)	Inch	(cm)	Inch	(mm)	
1/2	1.27	3/16	0.5	0.028	0.7	7
3/4	1.90	1/4	0.64	0.028	0.7	7
1-1/2	1.27	3/8	0.95	0.028	0.7	6
2-1/4	5.7	1/2	1.27	0.032	0.8	5
3	7.6	5/8	1.59	0.032	0.8	5
4-1/2	11.4	3/4	1.90	0.032	0.8	4
8	20.4	1	2.54	0.035	0.9	4
12	30.5	1-1/4	3.18	0.035	0.9	3
20	50.8	1-1/2	3.8	0.035	0.9	3

Blade speeds should be about 4,500 ft./min. (1,372m/min.) for material 1/16 to 1/8 inch (0.16 to 0.32 cm) thick, about 3,750 ft./mn. (1,143m/min.) for material 1/8 to 1 inch (0.32 cm to 2.54 cm) thick and about 3,000 ft./min. (915 m/min.) for material thicker than 1inch (2.54cm).

Fine teeth with no set will produce a smooth cut if the work is fed slowly. Generally, tooth size should be larger with the increasing thickness of the acrylic sheet.

Since any blade weaving or whipping will create additional frictional heat and will cause a ragged cut, suitable saw guides should be adjusted close to the work. POLYONE SAR sheet must be kept in continuous motion and the feed pressure must be applied evenly to minimize gumming tendencies and to prevent the blade from binding and breaking. The cutting blade should always enter and leave the acrylic sheet slowly to prevent chipping at the corners. As with the circular saw blades, band saws must be periodically cleaned with a solvent that will remove the gum accumulation.

**Tight Cutting with Jigsaws**

Use jigsaws for small-diameter curves and for interior cuts in acrylic sheet. The blades are narrow and can easily be inserted through a drilled hole. The jigsaw blades should be the metal-cutting types. Adjust saw guides as closely to the work as possible in order to minimize the weave of the blade.

Because the working stroke is short, frictional heat can build up quickly during cutting. Often, all of the chips do not have a chance to clear the blade. This can result in gumming. Feed the acrylic sheet slowly and steadily to prevent it from overheating and gumming and the fresh cut from reknitting. Jigsaws with integral blowers are useful to remove sawdust from the work.

**Other Saws and Cutting Devices**

*Portable Circular Saws.* Portable, high-speed circular saws are useful for trimming large formed parts of acrylic where it is more convenient to bring the tool to the work than the work to the tool. Extreme care must be exercised when using portable circular saws. The saw must be well-balanced and run without vibration. The acrylic part to be trimmed should be secured in a jig and well supported.

*Hole-cutting.* Tubular blades mounted in a drill press are convenient for cutting large round holes in cast and extruded acrylic sheet.

*Score-cutting.* The same method of scoring and breaking used for cutting glass can be used for straight-cutting POLYONE SAR acrylic sheet. Use a simple holding device to provide both an edge over which to break the scored acrylic sheet and a means of applying a uniform bending pressure. In general, the thicker the acrylic sheet to be cut, the deeper the score should be made.

**Routing**

Wood shavers or routers can be used to cut edges and slots of various shapes into pieces of POLYONE SAR acrylic sheet. The type of cutter used is determined by the desired shape of the cut.

In general, the greater the speed of the router, the fewer the cutting edges required to produce a clean, smooth cut. For example, square routing to templates can be best be accomplished with six-to ten-bladed cutters operating at peripheral speeds of 2,000 to 5,000 ft./min. (608 to 1,525 m/min.). Cutters with only two or three cutting edges that are 2 to 3 inches (5.08-7.62cm) in diameter would require speeds of 5,000 to 9,000 ft./min. (1,524 to 2,744 m/min.) for acceptable SAR acrylic sheet routing.

Blades should be kept sharp. The cutter should be ground with a back clearance of about 10o and a rake angle between 0o and 15o. For rabbet or step routs in SAR acrylic sheet, the cutting teeth should be backed off on the underside to avoid drag and burn marks. Whenever possible, the corners of routing cutters should be ground to a slight radius in order to produce a fillet at the bottom of the rout. Eliminating sharp corners prevents the concentration of stresses that can result in an acrylic part failure.

The POLYONE SAR sheet should be fed slowly and continuously. A suction system or an air blast will remove chips and help cool the cutter. Portable hand routers are useful for trimming edges of SAR sheet and for intricately designed surface routing.

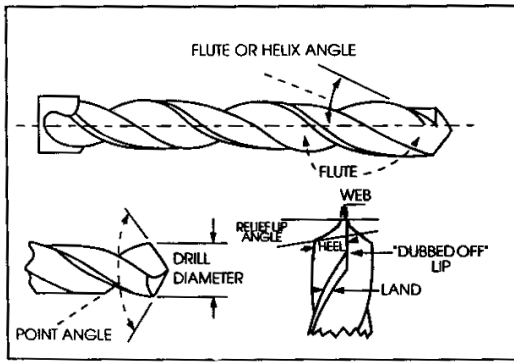
**Drilling**

To minimize chipping, firmly support both sides of an SAR sheet that you are drilling by using a specially designed jig or by clamping it to wood.

Standard vertical-spindle drill presses, as well as hand drills, may be used for drilling acrylic sheet. Twist drills can be used if their cutting edges are “dubbed off” to a 0° rake angle. Standard metal drills will pull and grab the acrylic sheet unless the cutting edge is also “dubbed off” to a 0° rake angle. Standard drills will perform well with acrylic sheet if they are modified to the following specifications (see Figure 1):

Flute or Helix Angle:	17°
Point Angle: (Angle depends on part thickness)	70° to 120°
Lip Clearance or Relief Angle:	4° to 8°
Polished Lands:	One-quarter the Width of the heel.

FIGURE 1 Drill Design



Deep and polished flutes facilitate the removal of chips. Nicks or scratches on the drill will mar the surface of the hole. If the proper drill, drill speed and feed rate are being used, continuous spiral chips or ribbons will form. For larger diameter drills, slower rotating speeds will give the best results.

Drill lubricants aid in chip removal, carry away heat and improve the surface finish of a hole. Good lubricants for drilling SAR parts are a soap-in-water solution or mineral oil. If you use mineral oil alone, you will have to perform an extra cleaning operation. In some cases, you may wish to add one part of mineral oil to as much as ten parts of a soap-in-water solution. You may also use the commercial coolant solution described in the "Cutting" section. When drilling deep holes, you should immerse the part in the coolant/lubricant. To allow the chips to be cleared and the hole to be filled with lubricant, withdraw the drill about every ½ inch (1.27 cm) and spray a steady stream of lubricant directly at the drill. Compressed air can often be used as a coolant for holes with a depth-to-diameter ratio of less than 5 to 1. Shallow holes can usually be drilled into SAR sheet without a lubricant if care is exercised to avoid overheating.

Hole saws and fly cutters are useful for cutting holes greater than 1 inch (2.54 cm) in diameter. A modified long-lead twist drill with a sharp lip angle is particularly useful for drilling thin sheets of POLYONE SAR.

### Threading and Tapping

It is possible to thread or tap POLYONE SAR acrylic sheet satisfactorily with standard thread forms. When threading or tapping POLYONE SAR, follow the recommendations described in the following paragraphs.

Such threads as the United States Standard (American Coarse Thread Series), Whitworth Standard (British Standard Series), and Acme is generally satisfactory. Sharp "V" threads are to be avoided due to the ease with which the apex fractures. Coarse pitch threads are preferred because of their added strength.

When threading or tapping SAR to fit a metal bolt or nut, allowance should be made for the different thermal expansion coefficients of the two materials. A slight increase over normal metal clearance is usually ample. In addition, when a number of bolt holes are drilled in line, the holes should be elongated to allow for lateral movement resulting from temperature changes.

If service temperature variations are extreme, dimensional changes will be too great and threading is not recommended. Use threaded metal inserts or fittings where the internal threads may be subjected to excessive shock or torque-loading or where it may be necessary to remove and reinsert the bolt frequently with the potential for wear or cross-threading.

Either hand or machine methods may be employed for threading or tapping POLYONE SAR. Standard taps and dies should be operated at 25% slower speed than is used for brass. Higher speeds cause excessive frictional heat and gumming of the chips. Taps should be backed out frequently to clear chips and avoid jamming.

When hand-tapping small holes (0.2 in [5.1mm] or less) you may not need to use lubricant if you exercise care. A lubricant such as mineral oil is recommended for drilling larger holes. For machine-tapping or threading, you should flood the work with the proper lubricant.

### Edge Polishing

Prior to polishing edges, remove saw marks by scraping with a hard steel scraper that has been square ground to a straight, smooth edge. After scraping, the edges should be wet sanded with 400 grit "wet-or-dry" sandpaper.

First, buff the edges with a wool felt wheel charged with polishing compounds such as very fine aluminum oxide combined with tallow. Operate a ten-to-twelve-inch diameter wheel at surface speeds of approximately 1,800 ft./min. Next, buff the edges on a felt wheel charged only with tallow. Perform a final polish with a soft cotton buff.

Flame polishing is not recommended since it can cause crazing of the abrasive-resistant coating and make it susceptible to solvent crazing by highly stressing the uncoated surface.

### Cleaning

Its abrasion, chemical and moisture resistant properties also make POLYONE SAR acrylic sheet very cleanable. This high degree of cleanability and chemical resistance allows you to use typical household cleaners to clean its surface. For best cleaning results be sure to always use a clean, soft cloth. Before wiping, wet the surface of the SAR sheet with the cleaning solution. If oily surface contamination exists, the cleaning solution may not thoroughly cover the surface until you have rubbed it with the cloth.

Typical household cleaners that have been tested and found effective for cleaning POLYONE SAR acrylic sheet include:

- "Easy-off" window cleaner with ammonia (Boyle-Midway Div., American Home Products)
- "Windex" glass cleaner with ammonia D (Dracket Products Co.)
- "Glass Plus" glass and appliance cleaner (Texize Chemical Co.)
- "Top Job" general purpose cleaner (Proctor & Gamble)
- "Mr. Clean" general purpose cleaner (Proctor & Gamble)
- "Fantastik" spray cleaner (Texize Chemical Co.)

Industrial cleaners that have been used effectively on POLYONE SAR acrylic sheet include:

- Neleco Subway Soil Solvent (Neleco Products, Inc.)
- C-1102 Alkaline Cleaner (DuBois Chemicals)

To remove pain or ink marks, a soft cloth saturated with isopropyl alcohol or hydrocarbon solvent such as VM&P naphtha is recommended. Abrasive cleaners are not recommended. Avoid using razor blades or other sharp instruments that may gouge the surface. However, stubborn water spots can be removed by rubbing with 0000 steel wool. When using automatic brush washing equipment, be careful to ensure that the equipment is optimized for cleaning windows made with POLYONE SAR acrylic sheet. Please contact your window supplier, bus manufacturer or POLYONE SAR for recommendations on ways to effectively use this equipment.

### Antistatic Cleaners

POLYONE SAR acrylic sheet will build up a static charge similar to that of uncoated acrylic sheet when wiped under dry conditions. However, the charge is more rapidly dissipated from POLYONE SAR sheet than it is from uncoated acrylic sheet (see Table III).

**TABLE III**  
**Relative Static Charge**

Time	POLYONE SAR Uncoated Acrylic	
0	10-18	10-18
1 hr.	2-3	10-16
3 hrs.	0.1-0.5	10-15
24 hrs.	0.1-0.5	5-10

Using an antistatic cleaner to clean POLYONE SAR sheet reduces the tendency for static charge buildup. Some commercially available antistatic cleaners that effectively clean POLYONE SAR sheet and reduce static, include:

- “Like-Magic” Type NI-5 (Merchandise Presentations, Inc. 3960 Merritt Avenue, New York, NY 10466)
- “Tend” Antistat Cleaner (Dawn Products, PO Box 24, Englewood, CO 80110)
- “Merix” Anti-Static #79 Concentrate (Merix Chemical Company, 2234 East 75<sup>th</sup> Street, Chicago, IL 60649)
- “Kleenmaster” Brillianize® (Chemical Products Company, 1213 Jackson Street, Omaha, NE 68102)

Follow the manufacturer’s directions when using the above antistatic cleaners. Laboratory tests indicate the recommended antistatic cleaners will effectively resist a charge buildup for more than 24 hours. The antistatic cleaners are listed in order of decreasing long-term effectiveness on POLYONE SAR acrylic sheet.

### Repair

Superficial blemishes on the surface of POLYONE SAR acrylic sheet can be repaired somewhat by polishing. However, the repaired areas usually do not possess the excellent optical properties that were initially present. When polishing SAR sheet, speed and pressure are critical factors. The piece should not be overheated. The polishing wheel should be kept in constant motion relative to the piece of SAR sheet.

If a scratch, gouge, etc., extends deep into the sheet, the surface must be removed and the substrate repaired. The abrasion resistance of the repaired area will be poor relative to the rest of the sheet.

There is no way to truly repair scratches in POLYONE SAR sheet because we do not know of an air-dry coating with excellent abrasion resistance. However, the scratches may be aesthetically improved by applying an acrylic lacquer. The lacquer will fill the gouge and restore gloss. The repaired area will not have the abrasion resistance of the surrounding sheet. It will be similar to uncoated sheet.

Formulations of two lacquers that laboratory tests have shown to be effective in repairing scratches are listed in Table IV. The first formulation is based on a very high molecular weight acrylic resin, ELVACITE® 2041. This resin has solubility characteristics (chemical resistance) that are similar to uncoated acrylic sheet. However, the high molecular weight limits solids at application viscosity. As a result, multiple coats are required to fill a scratch. The second lacquer is based on ELVACITE® 2021 Acrylic Resin. Since this resin is lower in molecular weight, the lacquer contains higher solids (three times more than the first lacquer formulation). As a result, fewer coats are required but it is slightly less chemical resistant than the first formulation.

To repair scratches using one of these lacquer formulations, proceed as follows:

1. Clean dust or chips from the scratched area with compressed air, a brush, or 0000 steel wool.
2. Clean the scratch of oils (from handling) or airborne contamination with a cotton swab (such as a Q-tip) that has been soaked with isopropyl alcohol. Isopropyl rubbing alcohol purchased at the local drug or grocery store is satisfactory. However, be sure the alcohol is:
  - based on isopropyl alcohol;
  - contains no dye, i.e., is water white;
  - contains no perfumes.
1. Carefully apply the lacquer to the scratch (es) with a fine artist’s brush.
2. Remove excess lacquer by applying scotch tape to the dried lacquer.
 

The excess lacquer will not adhere to the abrasion resistant coating. When the tape is removed, the lacquer will be removed from the undamaged area but will remain in the scratch.

**TABLE IV**  
**Formulations for Scratch Touch-Up Lacquers**

Component	% By Weight	
	E23863-145-1	E25863-145-2
ELVACITE® Acrylic Resin 2041	7.9	-
ELVACITE® Acrylic Resin 2021	-	24.8
Methylene Chloride	70.9	52.8
Methyl Ethyl Ketone	7.1	7.5
SD-2B Ethanol	14.1	14.9
Solids %	7.9	24.8

The information and recommendations in this publication are, to the best of our knowledge, reliable. Users should perform their own tests to determine the suitability of these products for their own particular purposes. Statements made herein, should, therefore, not be construed as representations or warranties. The responsibilities of PolyOne for claims arising out of breach of warranty, negligence, strict liability, or otherwise is limited to the purchase price of the material. Statements made herein concerning the use of the products or formulations described herein are not to be construed as granting a license to operate under any patent of PolyOne or another, or as recommending the infringement of any patent of PolyOne or another, and no liability for infringement arising out of any such use is assumed.