

Sawing acrylic sheet

FABRICATION
AND PLASTICS
MACHINING

by Elizabeth Grimes

You can cut acrylic sheet by scribing and breaking, by sawing or routing with power equipment, or by using a laser cutter. Scribing works best for straight cuts in thin sheet — 0.236 inch or less. It's practical when cutting small quantities of sheet material. Sawing and routing with power equipment suits both straight and curved cuts on any sheet thickness. Laser cutting is suited for both straight and curved cuts, and the maximum sheet thickness is dependent on the power (i.e., wattage) of the laser.

This article covers cutting acrylic sheet with several types of power saws, including circular (table, radial or panel), scroll, sabre, band, veneer and hole saws. In general, use the following:

- Circular blade saws for straight cuts.
- Scroll and sabre saws for rough cutting small-radius curves in thin sheet.
- Band saws for rough cutting larger-radius curves or for making rough straight cuts in thick sheet.
- Portable routers and woodworking shapers for cutting and trimming the edges of flat and formed parts of any configuration. CNC routers may be used for cutting intricate designs and curved shapes.

For sawing operations, keep masking intact to protect the acrylic sheet surfaces and to provide lubrication. Remember that acrylic sheet is a combustible thermoplastic material. Observe fire precautions appropriate for comparable forms of wood and paper products.



Table saws make straight cuts in Plexiglas® acrylic sheet to close dimensions.

Circular blade saws

Several kinds of circular blade saws are suitable for cutting acrylic sheet. Table saws vary in size from small, light-duty models to large, heavy-production models. Here the saw stays in position while the sheet moves through the cut. Use circular saws for cutting acrylic sheet to close dimensions. The most common table saw size 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. Consider using special fixtures to hold the work steady for accurate cutting and for safety reasons.

Radial saws and swing saws move while the work is held stationary. In general, use these saws 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 fall into two categories. The first has the saw blade and motor mounted above the material to be cut. The work sits on the table against a fence and the saw feeds through the work. The second type has the saw blade and motor mounted below the material to be cut. This type comes with a combination saw guard and hold-down bar. The blade extends through the table high enough to cut through the material. For safety, the saw blade must generally be retracted before the saw guard and hold-down bar can be released.

Panel saws come with either horizontal or vertical tables. The vertical saws take up less floor space. With vertical panel saws you may place acrylic sheet on the saw more easily. Additionally, you are less likely to scratch unmasked acrylic sheets.

Circular saws should have motors with sufficient power. A 10-inch diameter saw should be powered by 2-hp or more motor, while a 14-inch diameter saw by a 5-hp motor or more. The motors normally drive the blades directly (no gearing or belts) and run at a speed of 3,450 rpm.



Vertical panel saws permit easy placement of large acrylic sheets.

Choose saws equipped with heavy-duty, production-type fences, heavy duty guards and sawdust removal systems. Kick-plate switches and electromechanical or frictionless electronic motor brakes improve worker safety.

In high production operations, use programmable horizontal and vertical panel saws with a movable fence. The saw blades should have carbide-tipped teeth of the triple-chip style (also called the square and advance). With triple-chip-style teeth, 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, you must return such blades to the factory for sharpening.

For best results with acrylic sheet produced by melt calendaring, use circular saw blades with the largest diameter possible. The blades should have 60 carbide-

tipped teeth with a triple-chip tooth design. Teeth should be shaped with a 5° to 10° 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, resulting in poor quality cuts and shortened blade life. For maximum service life, use the carbide-tipped blades only for acrylic sheet or similar materials.

To minimize blade wobble, which can generate heat and possibly melt the sheet, Atoglas recommends using a single- or double-mounted, precision-ground, hardened-steel stiffener with a diameter 4 inches less than the saw blade. In addition, a blade with radial/side tooth clearance minimizes heat generation. Table 1A lists specifics on the recommended carbide-tipped circular saw blades.

Where the quantity of the acrylic sheet to be cut does not warrant the purchase of carbide-tipped blades, use high-speed steel blades designed to cut acrylic sheet. These blades are alloy steel tempered to permit filing. The teeth should have a positive rake angle of 0° to 10° and should be of uniform height and shape. When cutting 0.150" or thinner sheet, choose a hollow ground blade. Teeth of uneven height will cause chipping of the sheet and will place undue cutting strains on a few teeth, causing the saw blade to crack. These saw blades should be machine filed or ground.

For cutting very small quantities of acrylic sheet, you can choose standard hollow ground, fine-tooth blades or ply-tooth blades such as those used for cross cutting wood. Table 1B lists the recommended high-speed steel circular saw blade data for cutting various thicknesses of acrylic sheet.

Circular blade saw operation

To minimize both chipping and overheating tendencies, make sure that circular saw blades protrude about 1/2 inch more than the thickness of the acrylic sheet. Firmly hold the work against the fence, which must be parallel to the saw blade.

You can cut several sheets of acrylic sheet at one time by stacking them. But use a suitably designed holding fixture when cutting sheet stacks to close tolerances.

When cutting unmasked acrylic sheets, take care to avoid scratching the sheet surfaces. Cover working surfaces with some

Table 1A: Carbide-Tipped Circular Saw Blade Recommendations

Material Thickness	Type Saw	Diameter (Inches)	No. of Teeth	Rake Angle	Plate Thickness (Inches)	Kerf Width (Inches)	Additional Information
.030"-.080" Solid	Table (Hand Feed)	8	80	0°	.095	.075	.052" rim thick, 2" rim
		10	80	0°	.095	.080	.054" rim thick, 2" rim
		12	80	0°	.095	.085	.060" rim thick, 2" rim
.100"-.177" Solid		8	80	5°-10°	.072	.100	General: All teeth to be tipped with Premium No. 2 carbide ground to a triple-chip style with additional side clearance and slight corner level on square tooth.
		10	80	5°-10°	.072	.100	
		12	80	5°-10°	.090	.125	
		14	80	5°-10°	.105	.145	
.236"-.944" Solid		8	60	5°-10°	.090	.125	
		10	60	5°-10°	.090	.125	
		12	60	5°-10°	.090	.125	
		14	60	5°-10°	.105	.145	
1.5"-2" Solid		12	60	5°-10°	.105	.145	
		14	60	5°-10°	.125	.170	
		16	60	5°-10°	.135	.180	
.236"-.944" Stacked	Radial or Panel (Power Feed)	8	60	5°-10°	.090	.125	
		10	60	5°-10°	.090	.125	
		12	60	5°-10°	.105	.145	
		14	60	5°-10°	.105	.145	
1.5"-2" Stacked Cell Cast Sheets		14	60	5°-10°	.125	.170	
		16	60	5°-10°	.135	.180	
		18	60	5°-10°	.135	.180	

soft material such as medium-density felt and keep the surface free of dirt and chips.

Remove sawdust and chips remaining on the sheet surface after cutting by blowing with compressed air. You can wipe the surface with a damp cloth to remove sawdust that clings to the material because of static electricity. The damp cloth will also dissipate the static charge.

When cutting acrylic sheet with a table saw, use a cutting board for stacked/clamped material or for making cuts not parallel to another edge (angle cut). 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, use hold-down clamps when feasible. The clamps will also help reduce chipping. The manual feed rate should be uniform at a rate of 3 to 4 inches per second (15 to 20 feet per minute). Allow the saw to cut freely while maintaining the rated speed of the motor.

While coolants are not required for most sawing operations, a fine spray mist directed against the saw blade can produce exceptionally smooth cuts in thick sheet. Use a spray of detergent in water or 10 percent soluble oil in water. The oil must be compatible with acrylic.

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Table 1B: High-Speed Steel Circular Saw Blade Recommendations

Thickness to be Cut	Blade Thickness	Teeth per Inch	Type of Blade
.030"-.080"	1/16"-3/32"	8-14	Hollow Ground
.098"-.150"	3/32"-3/8"	6-8	Hollow Ground
.177"-.354"	3/32"-1/8"	5-6	Spring Set or Hollow Ground
.472"-.708"	1/8"	3-4	Spring Set or Swaged
.944"-2.000"	1/8"-5/32"	3-3-1/2	Spring Set or Swaged

Note: Recommendations are for hand-fed operations (3" - 4"/second). The number of teeth can be increased proportionately to the feedrate for automatic feed operations, short of overloading the motor.

For melt calendared sheet, the circular saws should operate at speeds of about 3,450 rpm. Feed the material at about four inches per second. To assure a smooth, chip-free edge on either single or stacked cutting of sheets, set the saw blade at a height only slightly greater than the thickness of the material being cut. You can eliminate or reduce gumming or welding of the sheets during stack cutting by applying compressed air or an approved liquid coolant to the saw blade and material.



Automatic edge finishing machine with a diamond-tipped spindle smooths saw cut, producing a fine and glossy edge to Plexiglas® acrylic sheet.

Clamp the stack if possible. To prevent rubbing, make sure that the saw arbor runs true and the blade plate is flat. Some fabricators with special cutting problems have found it helpful to purchase a circular saw blade with additional clearance behind the teeth — so called “no melt” blades. With these blades you can increase the feed rate up to six inches/second, and increase the height of blade above the plastic sheet short of develop-

ing chipping of the sheet. Atoglas recommends stabilizing discs to prevent wobbling of the saw blade, and to minimize heat generation.

Table 2 summarizes solutions for some circular saw cutting problems.

Band saws

Use band saws for cutting curves in flat sheets or when formed parts are rough trimmed. You can also use these saws for making straight cuts in thick pieces of acrylic sheet. For production work, large saws with a 30- to 36-inch throat perform 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 teeth per inch on the blade should decrease. See Table 3 for recommendations.

Metal cutting blades and, in particular, bimetallic blades, stay sharp longer than blades designed for cutting wood. Several manufacturers supply these blades in 100 foot coils. Simply cut the blades to the proper length and braze or weld the ends. Anneal and dress welds.

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

Table 2: Typical Circular Saw Cutting Problems and Possible Solutions

Chipping	Burning
<ol style="list-style-type: none"> 1. Slow Feed Rate 2. Decrease Blade Penetration 3. Support Material Continuously (Narrow Saw Slot) 4. Provide Hold Down 5. Increase Tooth Rake Angle 6. Ensure Teeth Are of Uniform Height 	<ol style="list-style-type: none"> 1. Increase Feed Rate 2. Increase Blade Penetration 3. Ensure Fence is Parallel to Blade 4. Use Blade Stiffener 5. Decrease Tooth Rake Angle 6. Ensure Blade Has Been Properly Sharpened 7. Use Blade With Greater Side Clearance

Table 3: Band Saw Blade Recommendations (Use Metal-Cutting Blades)

Thickness to be Cut	Blade Width (Front to Back)	No. Teeth Per Inch	Tooth Style
Up to .118"	3/8"	18	Regular (Raker Set)
.118" to .472"	1/2"	10 to 14	Regular (Raker Set)
.472" to 2"	3/4"	6	Skip or Buttruss



Use band saws for rough cutting larger-radius curves or for making rough straight cuts in thick sheet.

Special band saw blades, called “skip tooth” or “buttruss” blades, have been developed for soft materials such as plastics. These blades are 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 blades work well in reducing chipping when cutting sheet 0.472 inch thick or less.

Band saw operation

Adjust the tension on the saw blade just enough to prevent slipping on the wheels, but not enough to stretch the blade and cause misalignment. Set the guide rolls or blocks so they just miss the teeth but support the rest of the blade width. Set them so you can stop their rotation with pressure from the thumb and forefinger when turning the saw by hand.

Adjust the back-up roll so that it does not turn when the saw is idling, but make sure it provides support while the saw is cutting. When cutting formed sections, you may find it necessary to raise the upper guide. In this case, use extra care to ensure proper alignment. For added safety, set the upper guide as low as possible (within 1/2 inch of the acrylic sheet).

The action of the saw carries sawdust from the sheet and the masking paper onto the wheels. The dust builds up on the wheels and may cause the blade to run off track. To avoid this, you must remove this accumulation of dust. 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.

You can make internal cuts by drilling a hole through the acrylic sheet and cut-

ting 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 band saw, take special care to prevent scratching. Keep the saw table clean and free of nicks or burrs. Place brown paper or cardboard on the table under the unmasked sheet. You can use tape or rubber cement 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 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. In this way the main portion of the acrylic part will rise slightly above the saw table while the wood strip supports the kerf.

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

Scroll saws

Scroll saws can cut sharp radii and closed holes in thin pieces of acrylic sheet, but are less suitable for cutting thick sections or multiple sheets. Because of their 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.

When you use a scroll saw, lightly feed the work without forcing it. Clear the teeth often. As soon as the blade stops cutting cleanly, back it out, remove the chips, and cool the sheet. Welding of the plastic behind the blade may be reduced by using two blades mounted side by side, or by using an air blast to remove chips and cool the acrylic sheet.

You can also use a coolant. Masking material should always be left intact to provide lubrication and protect the sheet. Blades should be sharp with 10 to 14 teeth to the inch. Use hold-downs to prevent vibration.

Sabre saws

You can use portable sabre saws for making either straight or curved cuts in acrylic sheet. However, you must provide adequate support for the sheet since the vibration caused by the reciprocating action of the saw blade may chip or crack it. Adjust chisel-type sabre saws so that the cutting chisel stroke is about 3/16 inch greater than the thickness of the work to be cut. Place two thicknesses of corrugated fiberboard on the working surface under the 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 approximately 1/8 inch, driving the plastic chips into the board. You can use the same type of blades as those for scroll saws.

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 have considerable set and come in 3-inch and 4-inch diameters. 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.

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. Adjust the height of the saw to the proper distance above the table and move the work past the revolving blade.

These saws are not easily guarded and must be used with great care. Do not use carbide-tipped blades unless designated for high-speed operations.

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 fastened to the top of the tube permits it to 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 located in

the top of the saw allow removal of the cut-out discs.

Hole saws generally come 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.

For optimum results, cut the sheet halfway through, turn it over, and make the finishing cut from the other side. When cutting sheet greater than 0.236 inches thick, use a detergent/water lubricant and coolant. A sawn-cut hole is typically rough and often melted, requiring a post-finishing operation. You can achieve better quality holes achieved by machining with a router, a circle cutter, or a laser cutter. ■

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