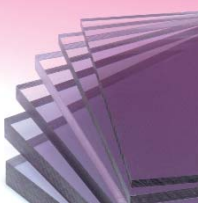

Guidelines for fabricating polycarbonate sheet

POLYCARBONATE

by Elizabeth Grimes

Often a variety of fabricating operations play a role in creating a desired polycarbonate component. (*The IAPD Magazine* covered thermoforming in the February/March 2002 issue.) How do you get the desired sheet size, create holes, and finish the final part? Here are some recommendations to help optimize these fabrication operations.

Sawing polycarbonate sheet

Tools for sawing polycarbonate sheet include circular saws for straight cuts and band and reciprocating saws for curved cuts. Routers are often used for trimming and deflanging. Sheet thickness, blade types and tool speeds affect cut quality.

Circular saws — At sheet thicknesses down to 0.015 inches, the horizontal overhead panel saw (Figure 1) gives a superior cut compared to table, portable, or under-the-table panel saws. Blades of 10 or more inches in diameter should have 60 to 80 carbide-tipped teeth. To minimize chipping, use a blade with triple chip ground (also called square and advance) teeth. This blade will stabilize the cut by reducing side pressure.

Table or bench circular saws produce severe chipping on sheet thinner than 0.118 inches. To minimize chipping:

- Use a narrower blade and a holddown.
- Set the blade height no more than 3/8 inch above the sheet.
- Try a blade with a negative rake angle of about 5E (Figure 2).

If heat develops and causes smearing, check the fence alignment and teeth sharpness. Hollow ground, carborundum, or steel blades give inferior cuts. Use portable circular saws only for rough cuts because of their poor control and accuracy.

Band and reciprocating saws — Smearing and welding of stacked sheets are common problems related to these saws. Band saws frequently cause smearing at low speeds. Select a blade with fewer teeth per inch to minimize this problem. Scroll (jig) saws with 10 teeth per inch provide an average cut on a single sheet, but stacked sheets will weld. A saber saw with four teeth per inch will cut faster than a scroll saw, but stacked sheets will also weld. (See the table on the next page for sawing recommendations.)

Figure 1. Author Liz Grimes uses a vertical panel circular saw to cut a large polycarbonate sheet. The panel saw is the best choice for sheet thicknesses less than 0.118 inches.

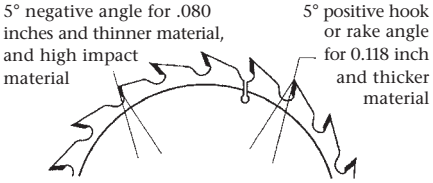

Figure 2. To minimize chipping of thin Tuffak® polycarbonate sheet when using a circular saw, choose a blade whose teeth have a negative rake angle of about 5°.

Scribing and breaking

Unless you're working with gauges of 0.060 inches or less, the practice of scribing and breaking polycarbonate sheet is not practical. The force necessary to propagate the notch is too high.

Shearing

Ordinary sheet metal shears can cut polycarbonate sheet up to 0.125 inches thick at room temperature. A tight clearance of 0.002 inches will avoid a rolled edge and burring in the heavier gauges. Paper cutters and hand shears can only be used in very thin gauges of sheet. Hot blade shearing is not a good idea as it creates other problems.

Industrial lasers

Cutting polycarbonate sheet with a laser often produces an edge having an amber or brown appearance. For this reason, this procedure is not commonly used, although it is gradually gaining acceptance.

Punching and steel rule die cutting

Sheet of 0.030 inches or less punches as clean as a drilled hole. Punching thicker sheet may cause rolling and burring. Use small clearances to reduce edge problems.

Cutting polycarbonate with a steel rule die is the best high production method of creating finished shapes for sheet up to 1/2-inch thick. An ordinary 4-pt steel rule die cuts sheet up to 1/8-inch thick. More complicated heavier dies require stronger backing and special ejection packing.

Figure 3. A modified 118° point angle twist drill bit for polycarbonate sheet provides optimum drilling. Atoglas Technical Assistant Gary Hall drills a slightly oversized hole for a fastener in this polycarbonate sheet.

Drilling a clean hole

Use a standard 118E point angle twist drill bit for PC sheet with the following modifications for optimum drilling:

- Grind a 10E back clearance at the cutting lip to eliminate friction.
- Dub off the 12E positive rake at 0E so there will be a scraping rather than digging action.

Without these modifications the drill will seize at any speed or feed and cause gumming and smearing.

Additional drilling recommendations:

- Do not use a drill designed for acrylic sheet, which will produce a burr at the exit edge of the hole.
- Employ a medium feed rate (0.015 inch per revolution) and slow drill speed (1,800 rpm) to produce the best holes with the least stress.
- Drill slightly oversized holes to accommodate mechanical fasteners (Figure 3).

Making large holes

Do not use hole saws which will cause severe chipping and smearing. Instead use a heavy-duty circle cutter (Figure 4) such as Stanley No. 419. This cuts a clean hole in polycarbonate sheet when a predrilled 1/4-inch hole serves as a lower bearing. The drill press must run true. For large holes, use a slower spindle speed and a feed of 0.002 inches per revolution.

Routing and jointing

For a good cut with no grabbing, use double and triple straight-fluted router bits, 1/2 to 3/4-inch diameter, with a 10E back lip clearance and a positive rake angle up to 5E. For an overhead router, select a spiral, four-fluted, carbide end mill to produce a semi-polished edge. Slower feed rates (3 to 4 inches per second) provide a superior finish. Choose the end mill with a down-cutting action to prevent chatter.

Steel routers give a satisfactory edge but will not last. To avoid heat buildup, the spindle should run at 20,000 rpm. Feed the sheet with a smooth, constant motion. In jointing, especially, a smooth constant feed is paramount to a good edge surface. Hold the polycarbonate sheet stationary by clamping it tightly. Computer controlled routing tables simplify cutting complex shapes in polycarbonate sheet (Figure 5).

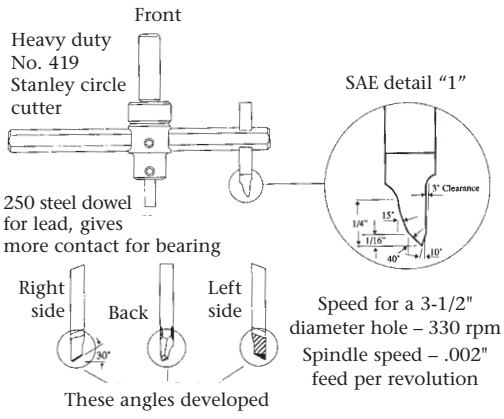

Figure 4. For cutting large holes in Tuffak® polycarbonate sheet, choose a circle cutter over a hole saw.

Sawing recommendations for Tuffak® polycarbonate sheet

Type of cut	Tool	Blade type	Blade parameters	Blade speed
Straight cut	Table circular saw (panel saw best for sheet thicknesses less than 0.118 inches)	Carbide-tipped, square and advance tooth	60-80 teeth for 14 inch diameter 60-80 teeth for 10 inch diameter 0° rake angle	3,400 rpm
Curved cut	Band saw	STD metal cutting	10 teeth/inch steel with raker set	7,500 feet per minute
Curved cut	Saber or jig saw	Metal cutting	10 teeth/inch steel	1,200 strokes per minute
Trimming and deflanging	Router	Carbide-tipped, double or triple straight fluted	1/2 inch diameter 5° positive rake angle	18,000 rpm

Figure 5. Atoglas Technical Assistant James Eastwood operates a computer controlled router, which follows an electronic template to create complex shapes in polycarbonate sheet.

Finishing

You can finish holes in, and edges of, polycarbonate sheet by either hand or machine. Use a light pressure to minimize friction from heat. Handle the sheet carefully to avoid surface scratching.

- Before polishing out scratches, sand the affected area to a final 600 grit. This minimizes buffing time and heat buildup, which cause stresses that could later result in crazing.
- Flame polishing often causes stress buildup from thermal shrinkage during cooling. So it may make the polycarbonate sheet more vulnerable to crazing. If you insist on flame polishing, first anneal the parts at 260EF for 45 minutes.
- A glossy edge similar to the edge obtained with the discontinued vapor-polishing process can be achieved with an automatic edge-finishing machine outfitted with a diamond-tipped spindle (Figure 6). Carbide spindles will produce an edge with a matte finish.

Clean polycarbonate sheet carefully because your wiping action may grind dust into the surface, scratching it. Use rubber gloves and splash goggles. To remove stubborn dirt, first wipe with a soft cloth saturated with a 5 percent solution of butyl cellosolve, followed by soap and water. After you clean the sheet, you may notice a deep, aging haze. If several mils deep, removal may require a combination of sanding and polishing. Yellowness is not just a surface phenomenon, but is evenly distributed throughout the sheet. Never use solvents to clean polycarbonate sheet, except perhaps very mild solvents such as VM&P naphtha, kerosene or isopropyl alcohol.

The next issue will cover the joining of polycarbonate sheets, and will include tips for painting and decorating. ■

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Figure 6. Liz Grimes achieves a smooth, glossy edge in Tuffak® polycarbonate sheet with an automatic edge-finishing machine outfitted with a diamond-tipped spindle.