Polycarbonate Fabrication Guide: Cutting, Forming, Bonding & Finishing

Polycarbonate (PC) machines cleanly, forms reliably, and survives abuse; but only if you control heat, moisture, and stress. This guide offers:

- Clear starting points for cutting, drilling, routing, and forming that work on common shop tools.
- Simple setup checklists that help you control heat, moisture, and stress before they cause problems.
- Clear temperature and timing ranges for thermoforming and bending so you know when to heat, form, and cool.
- Quick fixes for the issues you will actually see on the floor (melting, chipping, bubbles, webbing, cracking).
- Practical notes for fastening, bonding, finishing, cleaning, glazing, and brand/coating considerations you should keep in mind.

Use the quick start tables to set speeds and feeds, then jump straight to the process you are running:

At a Glance: Polycarbonate Fab Shop Settings & Setups

Machining & Cutting Polycarbonate

Operation	Tools & Geometry	Speed/Feed	Notes
Circular saw	Carbide, triple chip grind; 10–15° rake; minimal table gap	5,000–6,000 ft/min; up to 6,000–8,000 ft/min	Thin sheet (<1/8") use 8–12 TPI; ≥3/32" use 3–5 TPI. Keep masking on, support well.
Band saw	Precision/standard blades for thin; buttress/skip tooth for thick	2,000/1,500/1,000 ft/min for <1/8", 1/8–1/4", >1/4" respectively	8–12 TPI (<1/8"); 5–6 TPI (1/8–1/4"); 3–4 TPI (>1/4"). Support to avoid vibration.
Router	Straight 2–3 flute, 1/4"–1/2" carbide; 0–10° rake; 5–10° clearance	2,000/1,500/1,000 ft/min for <1/8", 1/8–1/4", >1/4" respectively	8–12 TPI (<1/8"); 5–6 TPI (1/8–1/4"); 3–4 TPI (>1/4"). Support to avoid vibration.
Milling/CNC	Sharp HSS or carbide; single flute spiral common	Cutting speed 100–500 m/min; feed 0.1–0.5 mm/rev	Clamp securely; air/water mist for heat; avoid cutting oils.
Drilling	Plastic geometry or HSS; 60–90° point; 0–5° negative rake	1/8": 1750 rpm; 1/4": 1000–1500; 1/2": 350–500	Oversize holes for thermal expansion; keep ≥2× hole diameter from sheet edge.
Shear	Guillotine preferred; 0.001–0.002" clearance	—	Shear up to ~1/4" (6 mm); flame retardant grades shear poorly. Trim sheared edges.
Die Cut	Steel rule; 3 pt (0.042") rule typical	Maintain ~0.005" punch die clearance	Effective ≤0.080" (2.0 mm). Calculate tonnage from perimeter × thickness.
Laser	CO_2 laser	—	Usable; expect amber/brown cut edges; ventilate well.

Forming & Bending Polycarbonate

Step	Setting	Guidance
Predry before thermoforming	250°F (121°C) in dehumidifying oven. Avoid still air ovens.	**Typical drying times at 250 °F are 0.093" — 4 hours, 0.118" — 6 hours, 0.150" — 8 hours, 0.177" — 12 hours, and 0.236" — 24 hours**. Times may vary by brand/grade; e.g., for 0.118" Tuffak® lists 4 hours, while Lexan® lists 6 hours. Always confirm the manufacturer's guide for your specific grade.
Polycarbonate forming temperature (vacuum/pressure)	350–360°F (177–182°C) sheet; molds 210–260°F (99–127°C)	**Uniform sag = ready to form**; maintain ~20 in Hg vacuum; dual side heating recommended ≥0.177".
Drape forming	~300–320°F (149–160°C)	Felt covered male mold; cool under pressure.
Hot line bend	155–165°C at bend zone	Masking may remain during hot line bending; wide parts may curve slightly (a "banana" shape). Cool while clamped in a jig to keep them flat.
Cold curving (installed radius)	Uncoated: ≥100× thickness; UV capped: ≥175×; hard coat: ≥300×	Avoid chemical exposure at stressed edges.

Machining & Cutting Polycarbonate

General polycarbonate machining rules

- Keep the protective masking on during machining to protect sheet surfaces; remove only if it interferes with the operation.
- Use sharp carbide or HSS tools with correct plastic geometry and steady feed to control heat and avoid melting.

- Hold sheets firmly—clamp or support them fully, minimize table gaps, and keep saw/router guides close to reduce vibration and edge chipping.
- Cool with compressed air or a light water mist; avoid petroleum cutting oils or aggressive coolants that can cause stress cracking.
- Clear chips continuously (air blast, vacuum, or peck drilling) and deburr edges after machining for a clean finish.

Circular sawing

- Use a carbide triple chip blade.
- Minimize the table gap to support the sheet and prevent chip out.
- **Troubleshooting:** If the cut is melting, increase the tooth size, reduce the speed, increase the feed, and cool with air. If the edge is chipping, use a finer tooth blade, reduce the feed rate, and add more support.

Band sawing

- Choose tooth pitch by thickness: 8–12 TPI for <1/8", 5–6 TPI for 1/8–1/4", and 3–4 TPI for >1/4".
- Set blade speed to 2,000 ft/min for <1/8", 1,500 ft/min for 1/8–1/4", and 1,000 ft/min for >1/4".
- Keep the saw guides close to the work and support the sheet fully to reduce vibration and prevent micro cracks.

Routing & CNC

- Run 20,000–25,000 rpm with 2–3 flute carbide bits for straight cuts.
- Feed against bit rotation for hand routers.
- On rigid CNC with strong workholding, climb passes can improve edge finish; otherwise use conventional.
- Use a fence for straight cuts.
- Avoid coolants that can attack polycarbonate.

Drilling

- Use plastic geometry or HSS bits with a 60–90° point and 0–5° negative rake.
- Clear chips frequently and cool with air.

- Drill oversized holes for thermal expansion.
- Keep hole centers at least 2× the hole diameter from the sheet edge.
- Typical drill speeds: 1/8" = 1750 rpm, 1/4" = 1000–1500 rpm, 1/2" = 350–500 rpm.

Shearing & die cutting

- Shear single sheets with 0.001–0.002" clearance. A guillotine shear is preferred.
- Steel rule die cutting works well up to 0.080" (2.0 mm).
- Use about 0.005" punch die clearance.
- Warm parts for cleaner cuts.
- Avoid sharp inside radii.
- Trim sheared edges.
- Flame retardant grades may shear poorly.

Laser cutting

CO_2 laser cutting of PC is possible but often discolors edges (amber/brown) and can add stress; ensure strong ventilation. For thicker gauges or optical edges, prefer sawing or routing.

Thermoforming Polycarbonate

How to Thermoform Polycarbonate

1. Predry the sheet in a dehumidifying, air circulating oven at **250°F (121°C)** for the time listed in the predry table, then move it directly to the forming station.
2. Heat the sheet to **350–360°F (177–182°C)** until you see uniform sag. For sheets ≥0.177", use heat on both sides.
3. Set the mold to **210–260°F (99–127°C)** and maintain about **20 in Hg of vacuum**. Use many small vacuum holes and keep the mold temperature consistent.

4. Form the part and hold vacuum or pressure through cooling so the shape locks in.
5. If you see bubbles, dry longer. If sag is uneven, balance the heaters or use screens. If details are soft, raise the sheet temperature or improve the vacuum seal.

Predrying (critical for bubble free parts)

Polycarbonate absorbs moisture; above ~250°F, it flashes to vapor and creates bubbles. Dry in a **dehumidifying, air circulating oven at 250°F (121°C)** and move directly to the former.

- **Typical dry times at 250°F:**
- 0.093" — 4 hours
- 0.118" — 6 hours
- 0.150" — 8 hours
- 0.177" — 12 hours
- .236" — 24 hours

Times may vary by brand/grade; e.g., for 0.118" Tuffak® lists 4 hours, while Lexan® lists 6 hours. Always confirm the manufacturer's guide for your specific grade.

Heating & forming window

- Heat sheet to **350–360°F (177–182°C)** until **uniform sag**; form with **~20 in Hg** vacuum. Single sided heat is fine to 0.177"; dual sided above that for penetration and cycle time. Molds: **210–260°F (99–127°C)**.
- Shading/screens can balance ovens and control sag over wide sheets.

Mold & tooling (mold support) materials

- Mold materials: use wood for prototypes, epoxies or filled resins for molds, and **aluminum for production molds**.
- Keep the mold temperature constant.
- Post form shrinkage is about **0.6–0.7% at a 120°C** mold. Oversize molds to match.
- To reduce witness marks, use many small vacuum holes **(0.5–0.75 mm)** and recess them on the back side.
- Add **5–7°** draft and generous radii/fillets to lower stress and ease release.

Process options for thermoforming polycarbonate

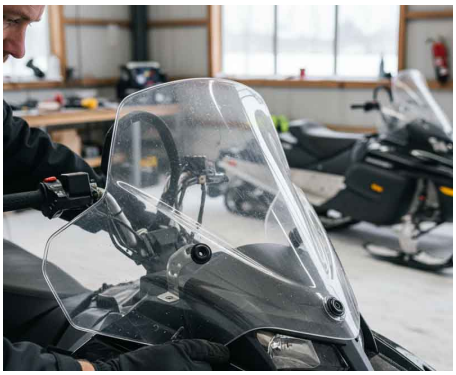
- **Vacuum forming** pulls a heated sheet against a mold using vacuum. Use this when vacuum alone can create the shape you need. Choose female or male molds, and optionally snap-back or plug-assist, based on where you want wall thickness and surface detail.
- **Pressure forming** and pyramids/domes use controlled air pressure on the heated sheet while forming. Use this when you are forming domes (typically **170–180°C**) or when you need to maintain pressure through cooling to lock the shape.
- **Twin-sheet forming** creates sealed hollow parts by heating and forming two sheets together. Use this when you need a sealed hollow part. Heat each face independently and control sag with photocells and hot air.

Troubleshooting thermoforming polycarbonate

- **Bubbles/blisters:** Predry the sheet longer and verify the oven temperature.
- **Non uniform sag:** Balance the heaters and use screens to even out heating.
- **Incomplete detail:** Raise the sheet temperature and improve the vacuum seal and airflow.
- **Webbing:** Lower the heat, increase spacing, and add a mechanical assist such as a plug.

Bending Polycarbonate (Without Full Thermoforming)

How to Bend Polycarbonate



- For crisp bends, use **hot line bending at 155–165°C**, make the bend immediately, and fixture the part until it cools.
- For small angles **at room temperature, use cold line bending**. Overbend slightly to hit the final angle after stress relaxes, and limit bends to about **90°**. Avoid bending hard coated or UV capped grades at the bend line.
- For gentle curves in installations, use **cold curving** and respect the minimum radius: **≥100×** thickness for uncoated, **≥175×** for UV capped, and **≥300×** for hard coated sheets.
- For straight bends on thicker stock, use **brake bending** up to about **0.100"** thickness. For **≥ 0.118"**, add strip heaters on both sides for even heat penetration.

Hot line bending

- Heat only the bend zone to **155–165°C**
- Bend immediately, and fixture to cool.
- Masking can remain during this process.
- Wide panels may curve slightly across their width after bending (a "banana" shape). To keep them straight, hold the part flat in a fixture while it cools.

Cold line bending

- Viable at room temp for small angles.
- Stress relaxes over 1–2 days. **Overbend** to hit the final angle and **limit to ~90°**.
- Avoid hard coat/UV capped grades at the bend.

Cold curving (installed radius)

Use the following minimum installed radius values for cold curving during installation. ***The installed radius is the curve radius after the sheet is mounted****. Tighter radii increase stress, so follow these limits.*

- **Uncoated** PC: ≥**100×** thickness
- **UV capped (e.g., EXELL D)**: ≥**175×**
- **Hard coated (e.g., MARGARD FMR)**: ≥**300×**

Thickness	Uncoated	UV capped	Hard coated
2 mm (0.079”)	**200 mm**	350 mm	600 mm
3 mm (0.118”	**300 mm**	525 mm	900 mm
4 mm (0.157”)	**400 mm**	700 mm	1,200 mm
6 mm (0.236”)	**600 mm**	1,050 mm	1,800 mm

Brake bending

Brake bending involves bending the sheet along a straight line at the bend zone, adding heat as needed. It is not recommended to brake bend or thermoform coated polycarbonate, unless it is a special brand/type of formable hard-coating.

- Brake bending up to **0.177" to 90°** is feasible.
- For **≥ 0.177"** use dual side strip heaters or frequent flipping for even heat.

Annealing

Annealing involves a low temperature heat soak that relieves stresses created by machining or bending before returning to room temperature.

- Fixture the part so it keeps its shape.
- Heat to **250°F (121°C)**.
- Hold for **15 minutes for every 0.125" of thickness**.
- Cool slowly with the blower on.

Fastening & Bonding Polycarbonate

When to use mechanical fastening or adhesives with polycarbonate

- **Use mechanical fastening** when you want a removable joint and need clearance for thermal expansion (use oversized holes, pan/round heads, and washers/gaskets; rivets with proper spacing are also suitable).
- **Use adhesives and solvent cements** when you want a bonded joint. Choose solvent bonding for fast, cosmetic joints (note the reduced impact at the joint). Choose adhesives (urethanes/epoxies, silicones, UV cure, foam tapes) when you need durability or flexibility, selected for compatibility, load, and environment.

Mechanical fastening

- Drill **oversized holes** to allow for thermal expansion. As a design rule, allow ~0.032 in/ft per 70°F (one direction expansion). For glazing across a typical seasonal swing (≈ ±70°F from install), allow roughly 1/16" per foot total (expansion + contraction). A precise estimate is $\Delta L = 3.75\times10^{-5}$ in/in/°F × L × ΔT.

- Use **flat underside screw heads** (pan/round), avoid countersunk heads (they induce hoop stress). Add large washers and compliant gaskets.
- **Rivets**: use aluminum/brass/copper with rubber washers; hole size ≈ **1.5×** expanded rivet diameter; spacing **5–10×** rivet diameter.

Adhesives (structural) & solvent cements

- **Solvent bonding** (fast, cosmetic). Use methylene chloride (fast) or ethylene dichloride (longer open time). Expect reduced impact at the joint. Keep humidity low to avoid whitening, and allow 24–48 h to cure before load.
- **Adhesives** (durable). Options include urethanes and epoxies (strong), silicones (flexible), UV cure (fast/high strength), and foam tapes (clean process). Select for compatibility, required stiffness, load, and environment.
- **Joint design** matters. Prefer lap, double lap, scarf, or tapered lap to shift load into shear. Butt joints are the weakest.

Finishing, Printing & Painting Polycarbonate

Polycarbonate edge finishing

- Start by wet sanding with 400–500 grit. Then, optionally perform a solvent polish with methylene chloride (a small addition of glacial acetic acid can reduce humidity blush). Finish by buffing on a two wheel buffer. Avoid flame polishing polycarbonate.

Screen/digital printing & paint

- Clean with 50:50 water/isopropyl alcohol, remove static with damp chamois or ionized air, use only polycarbonate compatible inks/paints, and avoid aggressive solvents (toluene, xylene, MEK) in mixes.

Hard coated sheets

- Do not print or paint on coated faces. For one-side coated grades, it's generally OK to reverse print on the uncoated side.

Cleaning Polycarbonate & Chemical Compatibility

Safe daily cleaning

Use mild dish soaps (Dawn®, Joy®) and ammonia free glass cleaner (vinegar or isopropyl alcohol only). Wipe with a soft microfiber cloth, then rinse and dry to avoid spots.

Avoid / Use with caution

Avoid or use with caution: ammonia or amine cleaners, strong bases (NaOH, KOH), many ketones and aromatic solvents (acetone, MEK, toluene, xylene), and methylene chloride contact outside controlled bonding. These can cause stress cracking, especially in stressed zones.

Polycarbonate Glazing & Expansion Allowance (For Installed Panels)

Design frames to allow for thermal expansion. Allow approximately **0.060" per 12"** over a 70°F temperature change. Engage edges fully. **Use EPDM or neoprene gaskets** and compatible sealants. Avoid bolting through the glazing when possible.

Common Polycarbonate Fabrication Problems & Quick Fixes

Symptom	Likely Cause	Fix
Bubbles after forming	Sheet moisture	Predry longer; verify 250°F oven temp; move straight to oven/former.
Melted/gummed saw edge	Tooth too fine; speed too high; dull blade	Larger tooth, reduce speed, increase feed, cool with air.
Chipping at cut	Feed to fast; poor support; blade wobble	Reduce feed; support sheet; check arbor.
Webbing in forms	Sheet too hot; draw spacing	Reduce heat; add plug assist or change mold spacing.
Cracks near fasteners	Countersunk heads; holes too tight	Use pan/round heads; oversize holes; add washers/gaskets.

Coated Polycarbonate Fabrication Notes (by Surface Type)

- **UV capped** (e.g., EXELL D / SL): cold curve ≥175×; print/paint only on uncoated side as directed.
- **Hard coated** (e.g., MARGARD / AR): avoid cold bends; do not print/paint on coated face; excellent abrasion/chemical resistance.
- **Uncoated GP**: best machinability and cold curving margin (≥100× thickness); solvent bonding possible.

Brand Specific Notes (Lexan®, Makrolon®, &Tuffak® Polycarbonate)

Is cutting and forming polycarbonate sheets different by brand?

In almost all cases, **major polycarbonate brands process the same**. Differences tend to be small and relate to recommended ranges (e.g., saw surface speed) or to specialty coatings/FR grades (which affect shearing and cold curving limits). When in doubt, follow your specific PC brand's datasheet.

Tuffak® polycarbonate

- **Cutting**: Use a conservative saw surface speed (**5,000–6,000 ft/min**). Keep masking on and support the sheet well.
- **Forming & bending**: Follow the same predry, thermoforming, and bending settings listed in Sections 2–3.
- **Notes**: Flame retardant grades may shear poorly; trim sheared edges.

Lexan® sheet bending and Lexan® heat forming

- **Lexan® sheet bending**: Use hot line bending at **155–165°C** and fixture until cool. Small angle cold line bending is possible; overbend slightly and limit to about **90°**.
- **Lexan® heat forming**: Predry at **250°F (121°C)**, heat to **350–360°F (177–182°C)** until uniform sag, and form with **~20 in Hg vacuum** with molds at **210–260°F (99–127°C)**.
- **Notes**: Do not print or paint on the coated face of coated sheets; for cold curving, use at least **175×** thickness for UV capped sheets and **300×** for hard coated sheets.

Makrolon® polycarbonate

- **Cutting**: Upper saw surface speed range can be higher (**6,000–8,000 ft/min**). Use a carbide triple chip blade and minimize table gap.

- **Forming & bending**: Use the same drying, forming, and bending settings as Sections 2–3; apply dual side heating for sheets ≥0.177".

Safety & Handling

- Wear eye and hearing protection; use guards and chip collection.
- Ventilate laser and solvent work; follow SDS and OSHA exposure limits.
- This guide summarizes practices sourced from our manufacturers and provides general, typical figures. Always consult the official manufacturer documentation for the specific grade and brand of polycarbonate you are using, and follow those instructions if they differ.

Polycarbonate Fabrication FAQ

Can I cut polycarbonate with common shop tools?

Yes, use a carbide-tipped saw blade (triple chip or fine tooth), keep the protective masking on, support the sheet, and use steady feed.

Do I need to dry polycarbonate before thermoforming?

Yes, predrying is typically required to prevent bubbles and steam haze during forming. Follow your sheet's datasheet for time and temperature.

What's a safe limit for cold bending?

Cold bend limits vary by grade and coatings. As a simple rule of thumb, use a large radius (on the order of 100× thickness or more); coated sheets usually require even larger radii.

Can I drill polycarbonate without cracking?

Yes. Use sharp bits, back up the exit side, moderate the feed, and slow the drill as it breaks through. Step drills or plastic specific bits work well.

Is laser cutting recommended?

Generally not for thick sheet. PC can discolor and stress crack from laser heat. Sawing, routing, or CNC machining is usually preferred.

Can I flame polish polycarbonate edges?

Not recommended as flame polishing can induce surface stress and future crazing. Use sanding/polishing methods instead.

What adhesives work for polycarbonate?

Use adhesives specifically rated for polycarbonate (structural acrylics or dedicated PC solvents). Avoid cyanoacrylates where stress crazing is a concern; always test on scrap.

Should I remove the masking for fabrication?

Keep masking on for cutting and drilling. Remove it before high heat forming or painting/printing unless the masking is rated for those processes.

How should I clean finished parts?

Use mild soap and water with a soft, non abrasive cloth. Avoid ammonia, strong solvents, and dry wiping.

Does polycarbonate have UV protection?

Many sheets have a UV protected side. Install with the UV cap side out. Check the sheet's masking or datasheet to identify the UV side.

How do I approach forming polycarbonate sheets for simple curves?

For gentle cold bends, use a large radius (≈100× thickness or more; larger for coated sheets) and overbend slightly. For heat forming, predry per the datasheet, heat to ~350–360°F (177–182°C) until even sag, form over smooth tools, and fixture until cool; remove or vent masking not rated for heat.

What are best practices for CNC machining polycarbonate to prevent melting or chipping?

When CNC machining polycarbonate, use sharp single or O flute cutters, generous chip load with moderate RPM, steady feed, and air blast or light mist for cooling. Support the work well, use climb cutting, and avoid dwelling to prevent melt back.

What is the polycarbonate forming temperature range for common grades?

PC forming temp is typically ~350–360°F (177–182°C) within a workable window around 340–380°F. Mold temps are often 210–260°F (99–127°C). Always confirm your specific grade.

What are recommended methods for polycarbonate edge finishing to get clear, smooth edges?

Deburr, then wet sand progressively (e.g., 220 to 400 to 800+), scrape or micro plane to square, and buff with plastic polish. Avoid flame polishing to minimize stress crazing.