## 16.1 TOOLS REQUIRED (OVEN DETAILS)

A proper oven is essential to conduct thermoforming.

The specification for a good thermoforming oven is fairly simple:

It has to be designed so that the entire sheet is heated to the same temperature at the same time.

Therefore, the oven must be able to fully enclose the sheet and heat Corian® **in a consistent and constant fashion.**

**It has to have controls over the temperature that are accurate, repeatable and predictable.**

It is quite possible to use small domestic ovens for doing small parts such as corners and buildup strips.

In addition to an oven, temperature-indicating labels (e.g., Celsistrips®) are required. Refer to the following checklist:

### Calibration Checklist:

- thermocouple thermometer
- temperature-indicating labels
- stopwatch or wristwatch with second hand

**Helpful Hints:**

Do not use a heating process that does not provide constant heat to the whole of the sheet, such as a postformer or a heat gun.

## 16.2 MATERIAL PREPARATION

Proper material preparation is essential for successful thermoforming.

An essential part of successful thermoforming is the radius of the bend.

Refer to Table 16.2.A as a guide to the minimum inside radius permitted when thermoforming standard Corian® thickness sheet material:

**Table 16.2.A**

| SHEET THICKNESS | MINIMUM INSIDE RADIUS |
|---|---|
| 1/4" (6 mm) | 1" (25 mm) |
| 1/2" (12 mm) | 3" (76 mm) |
| 3/4" (19 mm) | 5" (127 mm) |

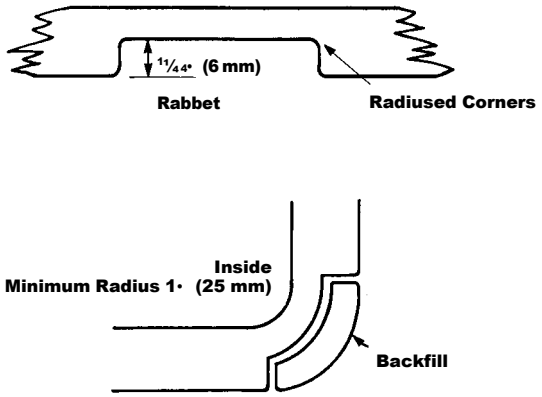
However, using the radius rabbet technique, we can reduce the radius below these recommended guidelines.

The technique requires a rabbet to be placed into the underside of the sheet adjacent to where the radius will be formed. This reduces the thickness of the sheet and thus allows a smaller radius to be formed.

The sheet is then thermoformed and, upon completion, backfill the rabbet section back to its original thickness.

Using 1/2" (12 mm) Corian® as an example, a rabbet is placed in the back of the sheet 1/4" (6 mm) deep and extending along the full depth of the curve.

**Figure 16.2.B**




This reduces the thickness of the sheet in the inside radius section from 1/2" (12 mm) to 1/4" (6 mm), and the radius can be reduced from 3" (76 mm) to 1" (25 mm).

STEPS TO COMPLETION:

## Standard material preparation:

1. Cut all pieces to slightly over their required dimensions.
2. Sand all material to a smooth matte finish.
3. Remove any chips and scratches from edges.

## Rabbeted radius technique:

1. Cut all pieces to slightly over their required dimensions.
2. Carefully calculate the area of each piece that requires the radius rabbet technique and measure and mark the rabbet on the sheet.

   Calculate the length of the curve by referring to the technique in Section 12.6 which calculated the circumference of the 90-degree curve: (2 x 3.14 x radius) ÷ 4.
3. Using a router and bit with rounded corners, rabbet the back.
4. Sand all material to a smooth matte finish.

5. Remove any chips and scratches from edges.
6. Thermoform sheet as per instructions.
7. After cooldown, prepare an inlay piece of Corian® to refill the rabbet.
8. Dam the ends of the rabbet and apply a generous quantity of Corian® Joint Adhesive to the rabbet, insert the inlay piece, clamp and allow to dry.
9. After Corian® Joint Adhesive has set, sand and complete to a matte finish.

**Helpful Hints:**

Be especially careful to ensure that all pieces are finished perfectly, free of any chips, deep scratches or any other imperfections.

## 16.3 OVEN PREPARATION

**Correct oven preparation and calibration is the most crucial step in thermoforming.**

Corian® should be heated to between 275°F (135°C) and 325°F (165°C) during bending. Lower temperatures may crack and whiten the Corian®.

Higher temperatures may blister, whiten or crack the Corian®. Colder or hotter material will be more brittle.

Heat-up times will vary depending on oven design and the size of the piece to be formed. Determine heat-up times for your oven by calibrating it.

Refer to Table 16.3.A as a guide to sample heat-up times:

Table 16.3.A

| SHEET THICKNESS | OVEN TEMPERATURE | HEAT-UP TIME* |
|---|---|---|
| 1/4" (6 mm) | 300°F (149°C)<br>350°F (177°C) | 30–60 min<br>15–30 min |
| 1/2" (12 mm) | 300°F (149°C)<br>350°F (177°C) | 45–80 min<br>25–60 min |
| 3/4" (19 mm) | 300°F (149°C)<br>350°F (177°C) | 75–105 min<br>50–85 min |

* approximate time

**Note:**

Oven temperatures exceeding 400°F (205°C) may overheat the surface of the sheet before the inside of the sheet reaches thermoforming temperature. A maximum oven temperature of 400°F (205°C) is recommended. **Do not exceed this temperature.**

Before thermoforming commences, a test must be run to calibrate your oven to find the best time/temperature for thermoforming.

STEPS TO COMPLETION:

1. Drill a 1/32" (.79 mm) diameter hole halfway into a test piece of Corian®.
2. Insert the thermocouple wire in the hole, bend it to fit and tape it in place.
3. Insert the wire plug into the thermometer. Turn on the thermometer; the meter temperature should now show the temperature of the sample.
4. Apply a temperature-indicating label near the end of the wire.

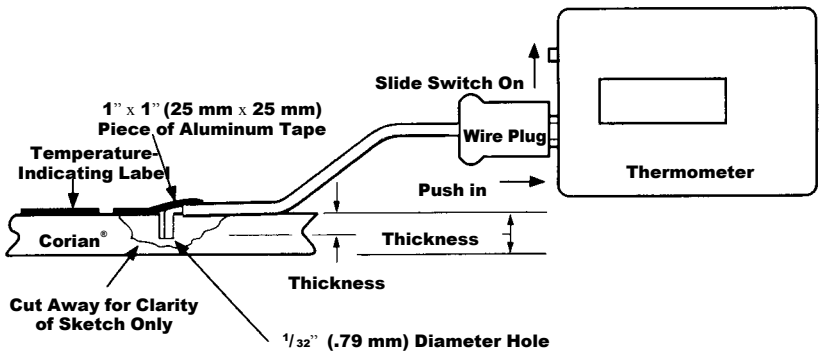



**Figure 16.3.B**

5. Turn the oven on and allow to preheat to 400°F (200°C) for 30 minutes.
6. Put the test sample in the oven and start the timer.
7. When the temperature on the thermometer reaches 295°–300°F (146°– 149°C), write down the timer reading and remove the piece from the oven.
8. Inspect the temperature-indicating label and note which dots turned black.

   If the strip blackened above 325°F (163°C), your oven is too hot.
9. Apply a new temperature-indicating label and rerun the test with a reduced oven temperature until the strip doesn't blacken above the 325°F (163°C) dot.
10. When 295°–300°F (146°–149°C) is reached on the thermometer without exceeding 325°F (163°C) on the temperature-indicating label, record the heating time.

    This will be the most effective time/temperature for your oven.
11. Remove the piece from the oven and allow the piece to cool until the thermometer reads 180°F (82°C).

    Note the timer reading. This is how long each piece should be cooled in the mold. This allows for proper cooling, even in a warm mold.

## 16.4 MOLD PREPARATION

Accurate molds should be prepared before commencing thermoforming.

### Design Considerations:

1. Recommended mold materials are medium-density fiberboard (M.D.F.) and plywood.

   • low cost
   • isotropic

2. Male versus female mold

   • To reduce the risk of wrinkling when molding deep shapes, a male mold is preferable to a female mold.

   • If a piece is to have a surface texture imparted by the mold, the mold type is automatically determined by the convexity/concavity of the surface to be textured:

   – texture concave surface requires a male mold
   – texture convex surface requires a female mold

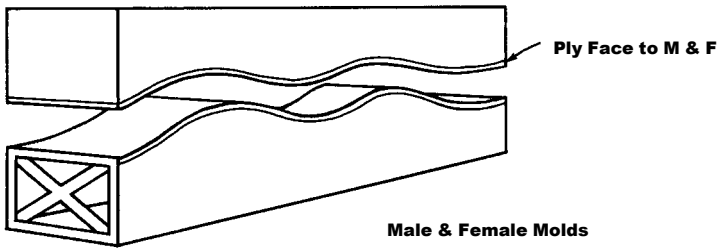



Figure 16.4.A

3. A deep and/or steep piece formed over a male mold will shrink around the mold as it cools and may stick to the mold. Incorporate a 5-degree (minimum) release angle into the mold.

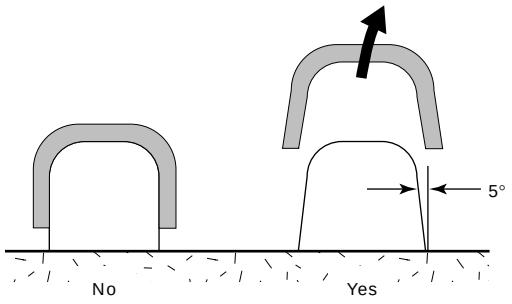
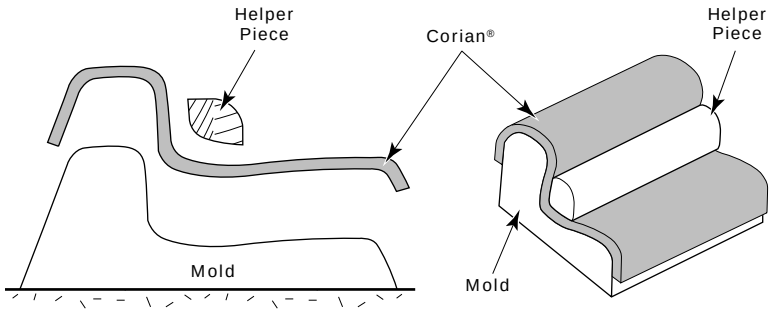



Figure 16.4.B

4. Use helper pieces in addition to the mold itself to:

   • do some initial shaping before vacuum membrane is activated
   • work with the vacuum membrane to help forming in difficult spots. For more information, see Section 16.6

**Figure 16.4.C**

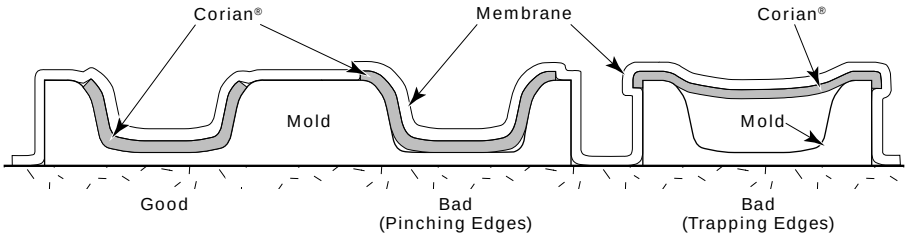



5. An option is to use a male mold in combination with a female mold.

   • advantage: positive control over material in mold.
   • disadvantage: more difficult to design initially and to change shape afterwards.

6. When using a female mold, bevel the cavity edges to prevent the material from being trapped between the forming membrane and the edge of the cavity. Make sure nothing inhibits smooth motion of the material as the membrane presses it into the cavity. This will allow the material to move fully into the mold. Above all, do not let the material get caught over a sharp edge.

**Figure 16.4.D**




7. Colored grades of Corian® turn white when stretched too far or too fast. If whitening is a problem, your options are to:

   • reduce curvature (increase radius) of the shape
   • slow the forming rate
   • use thinner material

8. Wrinkling most often occurs when material is compressed more than 10%. Reduce wrinkling by adjusting mold design and perform shape. **Under no circumstances should material undergo more than +/–25% strain.** Examine the formed piece to see what material will be cut away for the ultimate use, and cut away that material before you form the piece.

9. Making compound curves is the most difficult part of thermoforming. It helps if the design shape is symmetrical. Remember, maximum allowable stretch or compression is 25% (maximum stretch is reduced to 10–15% if whitening needs to be avoided).

STEPS FOR COMPLETION:

1. Using a jigsaw or router, cut the male and female shape in a good-quality plywood or M.D.F. board. A good-quality mold is essential, as any defect within the mold will be transferred into the face of the Corian® to be thermoformed.
2. Be sure that the internal supports of the male and female parts are close enough so that the mold is rigid when pressure is applied.
3. Face the male and female parts with 1/8" (3 mm) plywood or M.D.F. board, ensuring a perfectly smooth face.
4. Ensure that the male and female parts fit together neatly, allowing a gap sufficient for the thickness of Corian® that is to be thermoformed.

**Helpful Hints:**

Do not use metal or thick, solid wood on the mold faces, as these retain and absorb heat and slow the thermoforming and cooling process.

## 16.5 THERMOFORMING WITH STANDARD OVEN AND CLAMPING SYSTEM

STEPS TO COMPLETION:

1. Calibrate the oven with a sample piece, as per instructions in Section 16.3.
2. When you are confident of the scale of time/temperature, preheat the oven to the desired temperature.
3. Place the piece(s) of Corian® in the oven and start the timer.
4. At the expiration of the specified calibrated time, remove the piece(s) from the oven using hand- and arm-protective gloves.
5. Place the piece(s) in the mold(s) and clamp securely.
6. Reset the timer and wait until the calibrated cool-down time is expired.
7. Remove the piece(s) from the mold(s) with hand- and arm-protective gloves, allow to cool to room temperature then fabricate as required.

**Helpful Hints:**

Heat the entire piece. Spot-heating may cause problems; therefore it is important to heat the sheet uniformly.

Never attempt to thermoform a piece of Corian® that has a seam in it.

## 16.6 THERMOFORMING WITH HEATED PLATEN AND VACUUM MEMBRANE PRESS

A platen press, when used for thermoforming, will heat sheets much more quickly than an oven. This results in higher productivity. The platen press must be an electrical heating system capable of up to 400°F (200°C) or more. Alternatively, an oil-and-water heating system can be used.

Place the Corian® sheet into the preheated plate press with the heat setting between 300° and 325°F (150° and 160°C).

Adjust the press pressure to zero and lower the plates onto the Corian®.

Because the heat is applied directly to the surface of the Corian® sheet, the exposure time in the press will be reduced greatly from that of an oven. Normally, exposure of 10 to 15 minutes is sufficient in this mode.

DuPont recommends trial pieces of Corian® to determine exposure time.

DuPont recommends standard platen presses for door or laminating work

These guidelines are based on experience in thermoforming sheets of Corian®, 1/4" to 1/2" (6 mm to 12 mm) thick, in a vacuum membrane press.

## Tools Required:

1. Clamps, etc., for two-part mold
2. "Laser sight" or equivalent infrared temperature measurement device for checking material temperature (indirectly, by measuring surface temperature of membrane)
3. Template material (can be cardboard for research and development works, but should be tempered hardboard or similar material for production)
4. Saber saw (orbital motion saber saw recommended for fast cutting speed)
5. Forming equipment:
   - heated platen press
   - vacuum membrane forming press
     – alternates: low-pressure press or hand clamps
   - molds (male, female or both) of medium-density fiberboard (M.D.F.) or wood

STEPS TO COMPLETION:

## 1. Forming Process

**a. Preheat temperature** of material to be formed: 320°F, ±20° (160°C, ±10°).

**b. Heat-up time:**

- **in heated platen press:** ±1.5 minute per 1/16" (1.5 mm) (for example, 6 minutes for a piece of Corian® 1/4" (6 mm) thick

**c. Mold temperature: Starting from initial room temperature and going up to 120°F (50°C) after several pieces have been formed.**

**Note:**

The first piece of the day will cool and set more quickly than subsequent pieces. Wrinkling is easier to correct with a warmed-up mold.

**d. Forming pressure:** Ambient to 15 PSI (1 atm), maximum with vacuum membrane—

- No need for high pressure.
- Once the forming temperature is exceeded, moderate pressure is sufficient for forming.
- Below forming temperature, the material will rupture (break) rather than deform.

## 2. Forming Aids

a. To allow Corian® to slide into a female mold cavity, lubricate the surface with a light layer of talc (no lumps). This also helps the piece release from a male mold.

b. Insulated gloves must be used.

c. Use auxiliary forming pieces (for example, dowels) to concentrate membrane force. Placing the piece prior to deploying the membrane will "pre-tuck" the sheet into the mold.

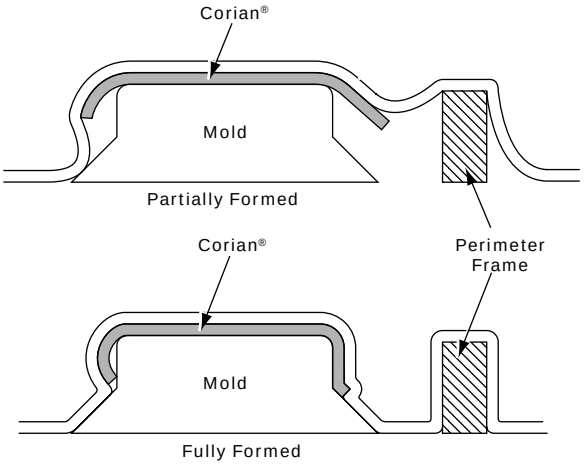
d. Perimeter frame is a technique to relieve forces on the edges of the formed material. Properly placed perimeter frame will cause the membrane to droop catenary-style over the material rather than "break" over its edges.

## 3. Forming Techniques

a. Drawing/stretching rate will influence whitening tendency—slower is better.

b. Keep material constrained until it cools to 180°F (82°C) measured at membrane surface, then release it to reduce stress.

**Figure 16.6.A**



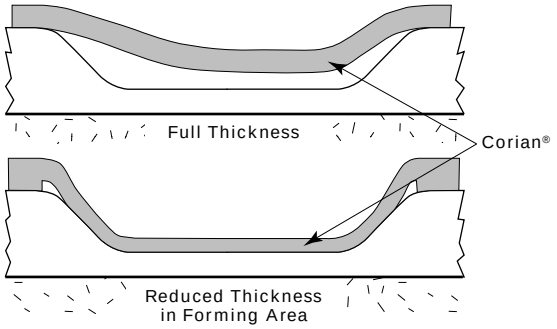

c. The thinner the material, the smaller the radius to which it can be bent and still avoid whitening.

d. Generally, thinner material thermoforms better than thick. If a thick piece is required, try reducing its thickness by machining in critical areas to improve thermoforming performance (e.g., change tray).

e. To avoid wrinkling, constrain material first where it is most likely to wrinkle. The usual method is to apply hand pressure on the forming membrane at the spot in question. This approach works best with a warm mold. **Warning:** Wear insulated gloves.

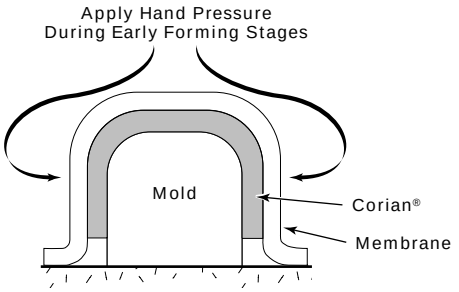
f. For best results, the piece should be cut slightly larger than its final outline before it is shaped. Determining ideal preform shape is a trial-and-error process. Make templates (or save the cutout holes in parent material) and

Figure 16.6.B




**number** your trials—**both** the template/cutout **and** the formed piece—so you learn what works.

Figure 16.6.C




## Index of problems and solutions

Figure 16.6.D

| SOLUTION SECTION | | PROBLEMS | | | | |
|---|---|---|---|---|---|---|
| | | Wrinkling | Whitening | Failure to Release | Not Conforming to Mold Shape | Safety |
| Mold Design | 16.4 | 2, 8 | 7 | 3 | | |
| Process | 16.6.1 | | — | — | — | a, b, c, d |
| Aids | 16.6.2 | — | — | a | a, c, d | b |
| Technique | 16.6.3 | e | a, c | — | b, d, f | — |

**Note:**
The DuPont product warranty is limited to the products made by DuPont (i.e., its range of sheets, shapes and accessories). The installed warranty is limited to installations done by DuPont Certified Fabricators and in accordance with the technical stipulations mentioned in the technical literature.

DuPont warrants the Corian® sheet in sheet-like applications. Three-dimensional thermoformed shapes (e.g., shower pan, bowl, etc.) made with Corian® and resulting from an additional production process on the Corian® sheet/shape is the responsibility of the fabricator/installer.