



# Thermoforming Sheet for Aircraft Interiors

## Radel® PPSU

Radel® R-7700 polyphenylsulfone (PPSU) thermoplastic sheet was developed specifically for aircraft interior applications. It offers low heat release, low smoke generation and low toxic gas emissions, thereby complying with the FAA regulation 14CFR Part 25.853 Appendix F. Materials for aircraft interiors must not only meet the latest FAA regulations, but often even more stringent requirements established by the industry. Radel® R-7700 sheet meets the current commercial and federal regulatory requirements for flammability, smoke density and toxic gas emissions.

Radel® R-7700 sheet has excellent impact properties and compares favorably to other competing resins in resistance to degradation by aerospace chemicals and solvents. Sheet is available with either textured or smooth surfaces. Smooth sheet can be textured during forming through the use of textured tooling. This document provides specific information regarding the thermoforming of the Radel® R-7700 sheet.

### Drying

Radel® R-7700 sheet must be thoroughly dried before it can be thermoformed. If not dry, it will foam or blister when subjected to the heat of the thermoforming operation. It is recommended that the sheet be dried at a temperature of 171 °C (340 °F) prior to forming. A desiccant-equipped dryer is preferred, but air circulating ovens have been used successfully. Cleaning of the sheet surface with isopropyl alcohol may be required prior to drying to remove any surface dust.

**Table 1:** Drying schedule for Radel® R-7700 sheet

Sheet Gauge [mm (mils)]	Drying Time [Hours]
1.0 (40)	4
1.5 (60)	6
2.0 (80)	8
3.2 (125)	12

Sheets should be racked in the oven with sufficient space between them, approximately 19 mm (0.75 inch), to permit adequate sweeping of the dry air over the surface of the sheets. The schedule for drying Radel® R-7700 sheet is shown in Table 1.

### Molds

Thermoformed prototypes can be produced with many types of molds such as wood, metal-filled epoxy or cast aluminum. Hardwood molds will only last for about 10 to 30 parts because of the high temperatures involved in forming Radel® R-7700 sheet. Cast epoxy molds may last for 100 to 300 parts. Cast aluminum is generally good for several thousand parts.

Production molds should be metal and cored for heating with a heat transfer fluid. Aluminum or steel molds are satisfactory, and the reproduction of the surface of the mold is excellent.

The design of thermoforming molds for Radel® R-7700 sheet should follow these conventional standards for rigid, amorphous materials:

- Avoid sharp corners by rounding them as generously as the part design permits, with a minimum corner radius equal to sheet thickness.
- Allow at least 3 degrees of draft on shallow parts and at least 6 degrees of draft for deep draw parts. In textured female molds, add 1 degree of draft per mil of texture undercut.
- Avoid undercuts if possible.
- Drill vacuum holes at 0.4 mm (0.015 inch) diameter, maximum.

## Thermoforming

The recommended heat density for the heating surfaces is 43 to 54 kW/m<sup>2</sup> (4 to 5 kW/ft<sup>2</sup>); 22 kW/m<sup>2</sup> (2 kW/ft<sup>2</sup>) is considered the acceptable minimum. The surface of Radel® R-7700 sheet must reach 260 °C to 288 °C (500 °F to 550 °F). Deeper draws require higher temperatures.

For example, heaters with a density of about 43 kW/m<sup>2</sup> (4 kW/ft<sup>2</sup>) set at 454 °C (850 °F) at a distance of 128 mm (5 inches) on both sides of the sheet will heat 2 mm (80 mil) sheet of Radel® R-7700 to thermoforming temperature in approximately two minutes.

During heating, the sheet will draw tight and then start to buckle between the clamps as the extruded strains are relieved. The sheet will then draw almost uniformly tight, and then start to sag. At the point of sag, the Radel® R-7700 sheet is ready for forming. Radel® R-7700 sheet has good forming latitude because of its high modulus at elevated temperature.

The mold should be operated at a temperature of 149 °C to 182 °C (300 °F to 360 °F) to obtain good mold surface reproduction and minimum strains. Radel® R-7700 sheet sets rapidly because of its high glass transition temperature and the product can be de-molded at sheet temperatures as high as 182 °C (360 °F).

Thermoformed parts will shrink as they cool to room temperature. Usually, the shrinkage of Radel® R-7700 sheet is uniform and predictable. Shrinkage should be considered when designing molds to achieve the desired finished part dimensions. Because the various mold materials have different thermal expansion coefficients, shrinkage figures for Radel® R-7700 sheet are measured from the difference between the mold dimensions at forming temperature and the part dimensions after cooling for 24 hours. Typically the mold shrinkage of Radel® R-7700 sheet, measured in this manner, is approximately 0.8 % to 1.0 %.

[www.solvay.com](http://www.solvay.com)

[SpecialtyPolymers.EMEA@solvay.com](mailto:SpecialtyPolymers.EMEA@solvay.com) | Europe, Middle East and Africa

[SpecialtyPolymers.Americas@solvay.com](mailto:SpecialtyPolymers.Americas@solvay.com) | Americas

[SpecialtyPolymers.Asia@solvay.com](mailto:SpecialtyPolymers.Asia@solvay.com) | Asia Pacific



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