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Durasein
Thermoforming



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Introduction

This fabrication bulletin addresses thermoforming of Durasein® solid surface, an alumina trihydrate filled acrylic solid surface sheet product.

Overview

Thermoforming of Durasein® solid surface sheet is the process of heating a lightly cross-linked thermoplastic sheet in an oven until it is pliable at a certain temperature, then forming it over a mold or into a specific design in a two-part matched mold and allow it to cool to solid form. After cooling then the shaped design is then trimmed to create a usable product.

Optimal results are obtained with thermoforming practice and experience.

Safety

Consult safety instructions provided by oven manufacturer. When handling room temperature molds and sheets wear appropriate protective gloves. Use insulated thermal gloves to prevent burns when working with hot sheet, molds and ovens. Arms should be protected with gauntlets. Wear safety glasses or approved eye protection, ear/noise protection and steel-toed shoes when fabricating and thermoforming Durasein® solid surface. Denatured alcohol (methylated spirits) and Acetone used for cleaning sheets are both flammable solvents and are considered hazardous.

Thermoforming Durasein® Solid Surface

Material Capability and Preparation

Thermoformability characteristics will vary by the product aesthetic. Veining in products may appear stretched upon thermoforming the material. Chromatic colors and darker colors, regardless if particles are present or not, when material is bent too fast during thermoforming or if material is not heated enough then white stretch marks will appear in the material. Medium-sized to large-sized particulate containing aesthetics, chromatic colors and darker colors will not perform as well as lighter colors or colors containing small-sized particulates. Colors

with clear, transparent particulates do not thermoform as well as lighter colors or colors containing small particulates and as a result, tearing around the clear, transparent particulates may occur or transparent particulates may whiten and change the product appearance. Colors with large-sized particulates when thermoformed may have increased surface roughness and may tear around large particulates.

Consult Durasein for a specialty product which has been formulated for deep bending enhanced thermoforming characteristics.

Material preparation involves removing any protective film if present, cutting material to oversized dimensions due to shrinkage of sheet upon heating and sanding pieces to matte finish prior to heating. Before heating sheet, material edges need to be eased and be smooth having no nicks, scratches, chips or cracks. These can be sites for sheet to tear while bending when sheet is hot and pliable. If sheet is too cool while bending then scratches, chips or nicks may induce cracks. Caution is advised when moving notched sheet as the heated sheet is pliable and may tear. Corners and edges of sheet will deform upon thermoforming. Trim cooled sheet to size to final usable part dimensions.

Heating Durasein® Solid Surface

The entire piece to be thermoformed must be fully enclosed in the appropriate oven for proper heat distribution and heated slowly, constantly and uniformly. Do not use torches or heat guns to spot heat specific areas of any pieces as this may induce stress due to temperature differences between unheated areas and heated areas which may result in product failure during thermoforming or upon cooling. Failure to uniformly heat product may induce stress resulting in cracking, breaking, whitening or stretch marks during forming. Heat the material according to the temperature recommendations provided by Durasein. Do not heat material too little, too much or too long. Underheating material may cause cracking, breaking, whitening or stretch marks. Prolonged heating of material may discolor the product. Overheating the material may result in cracking, whitening, discoloration or blistering. The alumina trihydrate filler in Durasein® solid surface begins to slowly decompose at 200°C (392°F).

NEVER heat seamed material as seams will come apart during heating. Form pieces to desired shape prior to joining and seaming.

Thermoforming conditions selected may cause some product types to have a slight change in color. Test finished color by doing surface matte or gloss finish sanding of a heat-treated piece and a nonheated piece; join these pieces together to confirm seamless appearance showing color has not noticeably changed. If color appears different adjust material heating time, oven temperature settings, repeat test and confirm color appearance.

If feasible, consider heating the sheets that are NOT to be thermoformed under similar conditions as heated thermoformed material if they are to be joined and seamed together in final assembly.

Ovens – Considerations and Temperature Measurements

Recommended for heating solid surface are dual platen ovens or hot air convection/circulating ovens. Platen oven or direct heat oven is typically two stainless steel plates where material is sandwiched between the plates and heated. Direct heat is faster and more uniform in a platen oven. Indirect heat ovens (convection/circulating) are more common, less expensive and require approximately five times longer to heat the material.

Infrared/radiant ovens are NEVER recommended for thermoforming Durasein® solid surface.

The oven should be able to heat to 200°C (392°F) and needs to be large enough to contain the entire piece of solid surface being heated. Note, ovens designed to heat above 177°C (350°F) can overheat sheet before the internal temperature of sheet reaches desired temperature – do not heat sheet above 177°C (350°F). An infra-red thermometer is recommended for reading temperatures of material throughout the thermoforming process. See Table 1. Durasein® Acrylic Solid Surface Thermoforming Parameters which provides recommendations for material thermoforming temperature and minimum bending radius.

Before commencing thermoforming, calibrate oven in order to determine best time and temperature for thermoforming the Durasein® solid surface material. Platen oven with temperature set to 150°C – 170°C (300°F – 338°F) will heat Durasein® solid surface one minute per each millimeter of thickness. [6 mm (1/4") thick material will heat to temperature in 6 minutes. 12 mm (1/2") thick material will heat to temperature in 12 minutes.]

Calibrating of Oven

1. Drill a 0.8 mm (1/32") hole halfway down into a test sample of Durasein® solid surface. A sample size of 305 mm (12") by 305 mm (12") at least should suffice with the hole placed in the center of the piece.
2. Insert a thermocouple into the hole, bending it to fit then taping it in place. Thermocouple wire needs to be of sufficient length to place solid surface sample inside the oven while attached to a recording device outside the oven.
3. Insert the wire plug into the digital thermometer. Turn on digital thermometer and observe temperature reading of the sample.
4. Turn on oven and allow oven to pre-heat at 165°C (329°F) for 20–30 minutes.
5. Place sample in oven and start timer.
6. When temperature reaches 160°C record the timer reading and remove the test sample from oven.
7. Read surface temperature of the test sample with an infrared thermometer. The surface temperature should be the approximately same as the oven temperature.
8. Place test sample in mold, set timer and allow test sample to cool to 82°C (180°F). Record time. This is minimum time for the thermoformed material to be cooled. If multiple parts are being thermoformed in same mold the mold will get warmer with repeat use and will impact time for part to cool to temperature.

Bending, Shaping and Molds

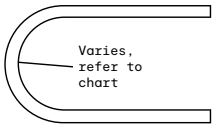
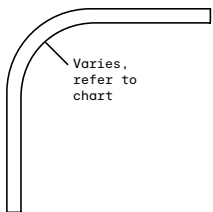
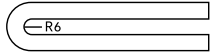
After material has reached the required temperature, using heat resistant gloves remove material from the oven and slowly bend or shape it into the desired form. If bending material too slowly it may cool too soon. If bending material too fast it may crack, break or introduce white stretch marks.

Construct matched molds with male and female mold parts for placing material between as it cools. MDF or plywood are commonly used for molds. Sanded, smooth surfaces free of defects are necessary as imperfections will transfer to the material being thermoformed. Wood-based molds can be used however, wood with pronounced grain patterns may transfer to the show surface so attention to sanding and finishing is required for the part. Molds should be designed so they can accommodate clamps to hold mold parts together as the material is cooling. Material needs to cool on its own accord to

about 82°C (180°F) before removing it from the mold. Removing the material at a higher temperature may result in material springing back some amount and the assembly fabrication then is more difficult or the part may need to be redone. Upon removal from mold, allow part to finish cooling to room temperature. Once material is rigid, normal finishing and cutting fabrication may be performed.

NEVER shock cool solid surface. Shock cooling will induce stress into the material.

Table 1. Durasein® Acrylic Solid Surface Thermoforming Parameters

	Color ranges	Thickness of sheet	Minimum outside radius	Temperature	Air circulating oven (heating time)
	Solid Colors	6 mm (1/4")	$R \geq 30 \text{ mm (1.2")}$	155°C - 165°C (311°F - 325°F)	15 - 25 min
		12 mm (1/2")	$R \geq 50 \text{ mm (2")}$	155°C - 165°C (311°F - 325°F)	20 - 30 min
	Colors with small particulates <0.4 mm	6 mm (1/4")	$R \geq 80 \text{ mm (3.2")}$	155°C - 165°C (311°F - 325°F)	25 - 30 min
		12 mm (1/2")	$R \geq 100 \text{ mm (3.9")}$	155°C - 165°C (311°F - 325°F)	25 - 30 min
	Colors with medium-sized particulates <5 mm and >0.4 mm	6 mm (1/4")	$R \geq 100 \text{ mm (3.9")}$	155°C - 165°C (311°F - 325°F)	25 - 30 min
		12 mm (1/2")	$R \geq 120 \text{ mm (4.7")}$	160°C - 170°C (311°F - 338°F)	30 - 35 min
	Special Thermo-forming grade	6 mm (1/4"), 9 mm (3/8"), 12 mm (1/2")	$R \geq 6 \text{ mm (0.24")}$	155°C - 160°C (311°F - 320°F)	20 - 30 min

Important information:

- Colors with large-sized particulates ($\geq 5 \text{ mm}$) do not thermoform well and may require an outside radius of $>150 \text{ mm (6")}$ as the material may have increased surface roughness and may tear around the large particulates.
- Colors containing transparent particulates do not thermoform well, as a result tearing may occur around the particulates. Transparent particles also may whiten when heated and change appearance of the material.
- Caution should be taken when thermoforming dark colors as color change (color lightening) may occur at thermoformed radii.
- 6 mm (1/4") Durasein® solid surface sheet is not intended for horizontal applications.

Heating Material in an Air Circulating/Convection Oven Steps

1. Condition material to shop temperature. Cold or warm material will impact heating times. Air currents and air movement in the shop may impact the consistency of temperature of material after removal from oven.
2. Have all personal protective equipment, tools and mold clamps available for use.
3. The oven has been calibrated.
4. Preheat air circulating oven to desired temperature settings. Allow oven to come to stable temperature.
5. Wearing proper personal protective equipment, place trimmed, sanded material into oven.
6. Close oven and start timer. Heat material to temperature indicated in Table 1. for time indicated; do not heat sheet above 177°C (350°F).
7. When material has been heated for designated time, open oven and check material temperature with infra-red thermometer.
8. Transfer material to be thermoformed to the mold. You have about 2 to 3 minutes to work before the material is too stiff. Take about 20 seconds to perform the desired bending. Hot material will burn bare skin.
9. Clamp material in the mold and allow to cool to at least 82°C (180°F) before removing it from the mold. Typically, this will take about 40 minutes. Gradual cooling is optimum.
10. Remove part from mold, allow to continue to cool to room temperature. Finish fabrication, sanding and seaming/joining as needed for the planned assembly.

Disclaimer:

Only fabricators experienced with the techniques, methods and equipment described in this fabrication bulletin should perform thermoforming. Durasein cannot regulate or control the adherence by a fabricator to the methods recommended in this fabrication bulletin. Therefore, Durasein does not warrant the condition of Durasein® solid surface while being thermoformed or material that has been unsuccessfully thermoformed.

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Heating Material in Platen Oven Steps

1. Condition material to shop temperature. Cold or warm material will impact heating times. Air currents and air movement in the shop may impact the consistency of temperature of material after removal from oven.
2. Have all personal protective equipment, tools and mold clamps available for use.
3. The oven has been calibrated.
4. Preheat platen oven to desired temperature settings. Allow oven to come to stable temperature.
5. Wearing proper personal protective equipment, place trimmed, sanded material into oven.
6. Close oven and start timer. Heat material to temperature indicated in Table 1. Typically it requires 6 minutes for 6 mm sheet to heat sheet to temperature or 12 minutes for 12 mm to heat sheet to temperature. Do not heat the sheet above 177°C (350°F).
7. When material has been heated for designated time, open oven and check material temperature with infra-red thermometer.
8. Transfer material to be thermoformed to the mold. You have about 2 to 3 minutes to work before the material is too stiff. Take about 20 seconds to perform the desired bending. Hot material will burn bare skin.
9. Clamp material in the mold and allow to cool to at least 82°C (180°F) before removing it from the mold. Typically, this will take about 40 minutes. Gradual cooling is optimum.
10. Remove part from mold, allow to continue to cool to room temperature. Finish fabrication, sanding and seaming/joining as needed for the planned assembly.