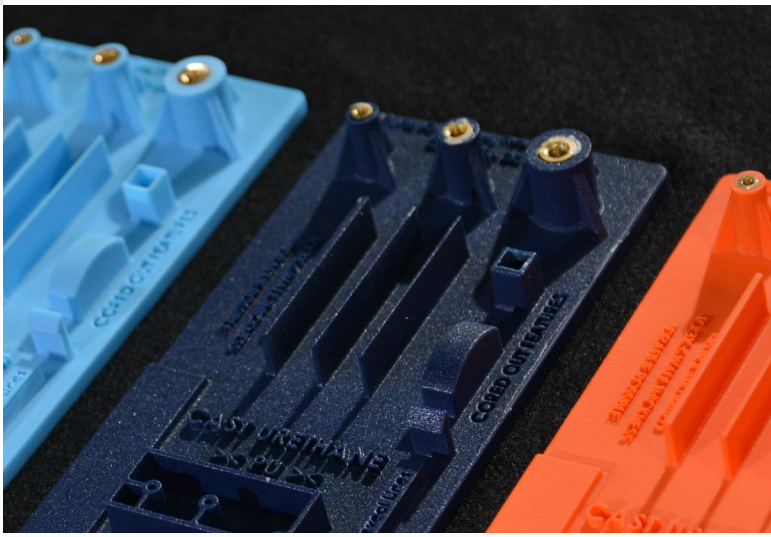


Urethane casting design guidelines

stratasys
DIRECT MANUFACTURING

Contents

1.0 Advantages of urethane casting 04

1.01 Cast urethane materials

2.0 Design guidelines 05

2.01 Wall thickness

2.02 Draft & undercuts

2.03 Ribs

2.04 Voids and shrinkage

2.05 Bosses

2.06 Rib guidelines

2.07 Radii and fillets

2.08 Joints between parts

2.09 Letter and logos

2.10 Snap fits and molded in hooks

2.11 Over-molding

2.12 Micro-welded inserts

3.0 Painting & finishing 10

3.01 Specifying surface texture

3.01 Part color

3.01 Color matching

3.01 EMI/RFI shielding

4.0 Technical details 11

4.01 Maximum part size

4.02 Minimum feature size

4.03 Accuracy

Urethane Casting
Design Guide

Urethane casting at Stratasys Direct Manufacturing includes a proprietary multi-step method that applies vacuum, heat and pressure to process Advanced Formula Polymers (AFP's) yielding void-free, strong and stable preproduction and short-run production components. The low-pressure injection molding into reinforced soft tools combines the benefits of platinum silicone molds (speed and versatility) with quantum improvements in mechanical properties utilizing AFP materials. Specifically, our AFP3100 has over three times the impact strength of earlier generation cast urethanes while offering excellent rigidity (high flex modulus).

Stratasys Direct's urethane casting methods include a compression molding process with flexible silicone material a casting process that adds composite sheet material (fiberglass, carbon fiber, Kevlar, etc.) into the cavity of molds. The result is a very tough and stiff composite reinforced cast urethane part with B-side detail captured. Typical cloth to resin ratios are 27 - 41%.

Advantages of urethane casting

1. Low-cost molds

Molds are cast using platinum silicone around master patterns built utilizing 3D printing technologies like Stereolithography (SL) and PolyJet, as well as CNC machining. The molds are generally good for 20 - 25 reproductions.

2. Short lead times

Upon receiving CAD data, typical cast urethane projects can be shipped in 3 - 10 days.

3. Greater design flexibility

- Parts designed for injection molding can be easily cast as urethanes.
- No lifters or slides are necessary. Most undercuts are acceptable – draft is not a concern.
- Thin and thick wall sections (non-typical wall thicknesses) can be present in the same part.
- Threaded inserts are micro-welded into place. The resulting torque and pull out strength are far superior to conventional heat staking or bonding of threaded fasteners into plastic parts.
- Small features are acceptable. Even figurines can be cast.
- No sink issues.
- Snap-fit friendly materials are available.
- Cast-in surface textures are not a problem. MT-11000 to MT-11040, MT-1055-1 to MT-1055-7 and SPI/SPE A1 to D3 are all available. Note that cast-in texture can reduce mold life.

Cast urethane materials

Stratasys Direct Manufacturing has a wide selection of Advanced Formula Polymer (AFP) and Shore A flexible materials to suit most applications. UL 94-V0 and FAR 25.853 flame ratings, high temperature, clear and medical imaging materials are all available.

There is also a family of foam materials available with variable densities ranging from 3 to 32 lbs. Materials can be cast in color and textured to achieve the look you need or painted and textured to provide UV stability.

Design guidelines

Urethane casting production consists of three processes once CAD data is received by Stratasys Direct Manufacturing:

1. Production of a master pattern utilizing Stereolithography, PolyJet or other additive manufacturing technologies, or with CNC machining.
2. Creation of a platinum silicone mold.
3. Casting of parts utilizing our proprietary casting method.

The process provides greater freedom and flexibility in producing parts compared to other manufacturing technologies.

Wall thickness

Minimum wall thickness for cast urethane parts is 0.020” and 0.050” for parts. While a good design practice is to maintain a uniform wall thickness, you can vary your wall thicknesses in the urethane casting process without impacting the resulting parts. The process is ideally suited when you require non-typical wall thicknesses.

Draft & undercuts

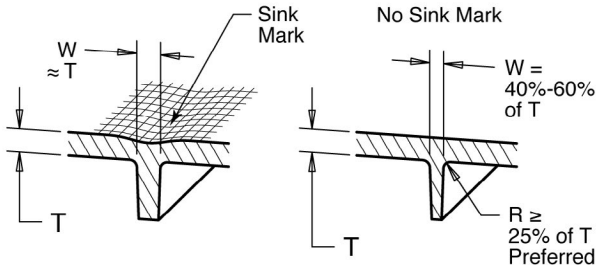
Draft and undercuts are not a concern when designing for the urethane casting process itself. However, if you’re building prototypes that are intended to move on to another production method like injection molding where hard tooling is required, you should create your design as intended for production. The urethane casting process is still ideal for prototypes and short runs of parts that will move on to other production technologies.

Ribs

Ribs are used in a design to increase the bending stiffness of a part without adding thickness. Ribs increase the moment of inertia, which increases bending stiffness.

Bending Stiffness =
E (Young’s Modulus) x I (Moment of Inertia)

Rib thickness should be less than wall thickness to minimize shrink and sinking effects. The recommended rib thickness should not exceed 60 percent of the nominal thickness. Plus, the rib should be attached with corner radii as generous as possible.



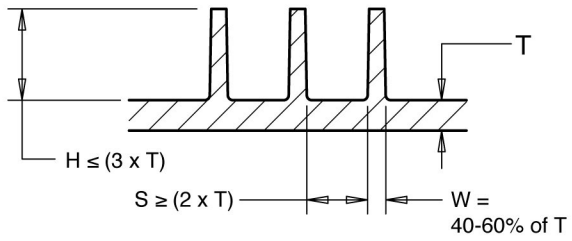
Rib intersections

Because the thickness of the material will be greater at the rib intersections, coring or another means of material removal should be employed to avoid excessive sinking from occurring on the opposite side.

Design guidelines

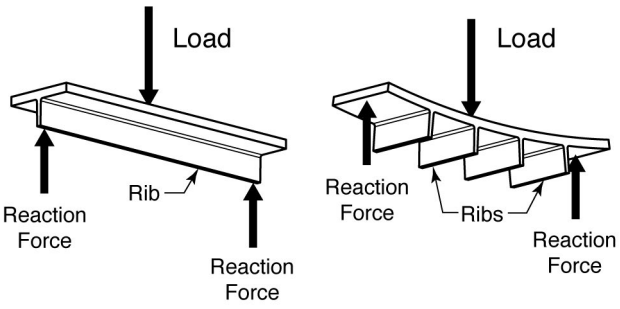
Rib guidelines

The height of a rib should be limited to less than three times its thickness. It is better to use multiple ribs to increase bending stiffness than to use one very tall rib.



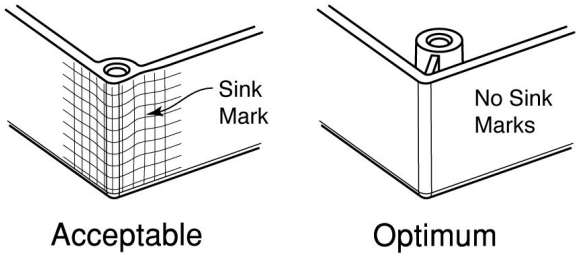
Rib/load effect on stiffness

A rib is oriented to provide maximum bending stiffness to the part. By paying attention to part geometry, designers must be conscious of the orientation of the rib to the bending load, or there will be no increase in stiffness.



Voids and shrinkage

In most molding processes, troublesome shrinkage problems can be caused by the intersection of walls that are not uniform in wall thickness. Examples might include ribs, bosses, or any other projection of the nominal wall. Since thicker walls solidify slower, the area they are attached to at the nominal wall will shrink as the projection shrinks. This can result in a sunken area in the nominal wall. Such shrinkage can be minimized if a rib thickness is maintained between 50 - 60% of the walls they are attached to. To further our example, bosses located in a corner produce very thick walls, causing sink, unless isolated as in the illustration below.



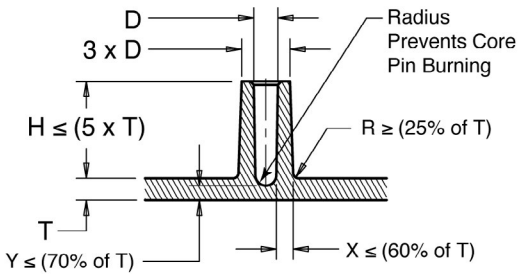
Typical sink marks from the injection molding process are minimized with cast urethanes.

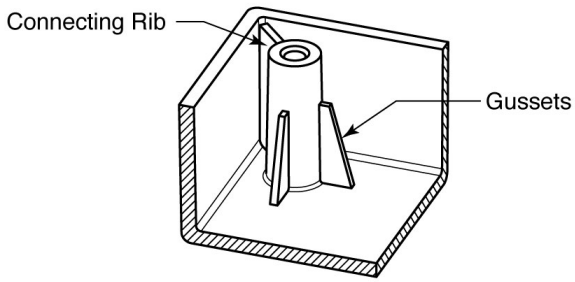
The urethane casting process offers an advantage over typical molding processes. While injection molding will leave sink marks as shown in the image on the left above, the geometry is acceptable for urethane casting and won't cause sink. If the design is ultimately going to an injection molding process, you'll still want to isolate the boss from the corner as shown in the image on the right.

Design guidelines

Bosses

Bosses are used to facilitate the registration of mating parts, for attaching fasteners such as screws, or for accepting threaded inserts.





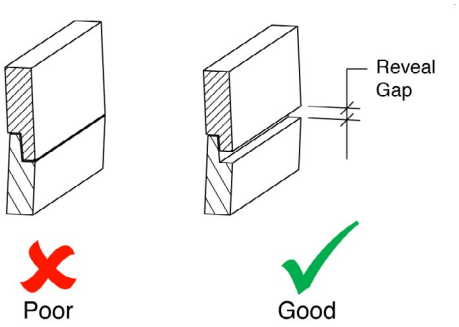
Wall thicknesses for bosses should be less than 60 percent of the nominal wall to minimize sinking. However, if the boss is not in a visible area, the wall thickness can be increased to allow for increased stresses imposed by micro-welded inserts or self-tapping screws.

The base radius should be a minimum of *0.25 X thickness*. Bosses can be strengthened by incorporating gussets at the base or by using connecting ribs attaching to nearby walls.

Design guidelines

Radii and fillets

A fillet radius of 0.125” is recommended on inside corners to increase strength. The inner corners of bosses can use 0.060” radii to help reduce wall thickness. Use these radii whenever you make transitions between surfaces. Radii are important because rigid urethanes are notch sensitive materials.



Joints between parts

Good design practices recommend that a part in an assembly take its position from its mating part. The urethane casting process offers many options for locating parts relative to one another. Industrial designers often want to incorporate reliefs into the joints between parts.

General guidelines for overlap joints in common situations:

Size of Part (length of part’s perimeter)	**Reveal Gap**
< 10”	0.025”
10 - 20”	0.040”
20 - 60”	0.060”
> 60”	0.080”

Tongue and groove joints can be used to fully locate one plastic part relative to another. The inside portion of the groove can be localized, or it can be continuous around the entire perimeter of the part. Allow clearances between the tongue and groove for tolerances and paint thickness (if any). Allow more clearances if the tongue and groove feature extends around most of the parts’ perimeters. Increase the length of the step or rabbet joint as the size of the part increases. Larger parts need a larger reveal gap and interlock to compensate for tolerances and to provide a proportionate look.

Letter and logos

Both raised and recessed letters and logos can be molded into cast urethane parts. The key factors are height or depth of the feature, width of the feature, radii on the feature and space between features. The recommended minimum space between features is 0.050”. Width to height ratios should be at least 2. The radii should be at least equal to half the height. Larger radii are better.

Snap fits and molded in hooks

Snap fits can be used in all urethane casting processes following design practices used for thermoplastic resins. Molded in hooks can speed assembly time and save the cost of hardware, and are often used to attach component parts, PC boards, tubing, and electrical wires.

Over-molding

Stratasys Direct offers the option of over-molding your cast urethane parts. Typically, an elastomeric urethane material is molded over a rigid urethane substrate to form a component part incorporating both soft and rigid materials. Other over-molding options like threaded studs, posts, nut plates, strain reliefs on electrical cords or metal stiffening components are available as well.

Design guidelines

Micro-welded inserts

Micro-welded inserts were developed at Stratasys Direct as an answer to our customers' requirement for extremely strong installment of threaded inserts. Our torque test results demonstrated that the micro-welded inserts in urethane cast parts were on average 50 - 100% stronger than bonded inserts and over 100% stronger than heat staked inserts. The chart below is intended as a design guide for Dodge Ultrasert II inserts to be Micro-welded into place using Stratasys Direct Manufacturing proprietary system.

Insert size	Hole Depth (in.)	Hole Diameter (in.)	Minimum Boss OD (in.)
4-40	0.135 or 0.219	0.172	0.232
6-32	0.150 or 0.250	0.219	0.290
8-32	0.185 or 0.312	0.250	0.350
10-24	0.225 or 0.375	0.297	0.430
¼-20	0.300 or 0.500	0.375	0.520
M2.5 x 0.45	0.135 or 0.219	0.172	0.232
M3.0 x 0.5	0.150 or 0.250	0.219	0.290
M3.5 x 0.6	0.150 or 0.250	0.219	0.290
M4.0 x 0.7	0.185 or 0.312	0.250	0.330
M5.0 x 0.8	0.264 or 0.437	0.328	0.460
M6.0 x 1.0	0.300 or 0.500	0.375	0.520

Painting & finishing

Specifying surface texture

Stratasys Direct Manufacturing offers multiple textured surface finishes on cast urethane parts specified through the Moldtech guide from MT-11000 through MT-11040 and MT-1055-3 thru MT-1055-7, or smooth surfaces between SPI/SPE A1 to D3. The preferred method is to texture the master pattern by using a specially adjusted paint spray gun to achieve the specified texture, which transfers to the mold and ultimately to the finished parts. Texture painting can also be applied to individual casted urethane parts. This is sometimes necessary to maximize mold life.

Part color

Cast urethane parts can have cast-in color and texture or can be painted to achieve the color, gloss level and uniform surface appearance desired. While cast-in color has the advantage of not chipping or peeling, painting can eliminate mold parting and witness lines and differences in shade that can occur with changing wall thickness and has greater UV stability.

Another option for applications where parts may be scratched is to cast in a matching color to the painted parts. This provides a "scratch resistant" color-on-color that will have a better appearance over time for production applications in demanding environments.

Color matching

Paint color is best established by specifying the color you want to achieve, typically done by specifying a PMS (Pantone Matching System) color. When casting colors, we can commit to providing a shade in or out of the specified color as the casting process involves manually mixing the two-part urethane with color immediately before casting. If an exact color match is required, painting may be your better option as there's more control over the process.

Some cast-in metallic looks can be achieved through additives to the raw urethane materials but consistency and uniformity will most often require the use of metallic paints.

EMI/RFI shielding

Plastic enclosures designed to house sensitive electrical components often require EMI (Electro Magnetic Interference) or RFI (Radio Frequency Interference) shielding.

EMI and/or RFI are generated by the electronics or power supplies in your device or exposure from other devices can generate it and cause interference with your device.

Stratasys Direct Manufacturing offers EMI/RFI shielding formulas specifically designed for use with plastic parts in copper, nickel and silver. These formulas can be applied to the specified surfaces of your cast urethane parts to achieve effective EMI or RFI shielding.

Technical details

Maximum part size

Approximately 1,000 in^3. Parts need to be reviewed on an individual basis to determine compatibility with Stratasys Direct Manufacturing's casting processes.

Minimum feature size

Shallow and small surface features of any size can be reproduced (a thumbprint on the master pattern may show up on the final parts). A minimum wall thickness of 0.020 - 0.040" is required for parts and 0.050" for and parts. All minimum wall thickness requirements need to be reviewed with manufacturing.

Accuracy

Standard tolerances are ± 0.015" or ± 0.003"/", whichever is greater. Tighter tolerances may be offered on a case-by-case basis.