APPLICATION GUIDE:

RTV Molding with Soluble Cores

TIME REQUIRED ■□□ COST ■■□ SKILL LEVEL ■□□

By Steve Gibson, Stratasys, Inc.

OVERVIEW

RTV molding can produce intricate and complex urethane castings quickly and affordably. In most cases, features that are challenging for machined tooling are easily addressed. However, there is a condition that complicates the RTV molding process. When the rubber mold or a loose insert cannot be extracted from the casting, an alternative approach is needed.

Geometries that can lock a part in the rubber mold include internal passages and cavities that neck down or snake through a part. Examples include a radiator hose (figure 1), valve body, water tank, bottle, arterial structures, etc.

There are two options to address this molding challenge. The first is to cut the part, mold it as individual pieces and bond them after casting. The second is to produce a core that is dissolved or melted after the urethane casting is extracted from the mold. If a few simple cores are needed, they can be machined. However, for complex geometry large quantities of castings, or in a time crunch, a second RTV mold may be optimal.

FDM AND SOLUBLE CORES

Parts built on a Fortus 3D Production System with FDM technology offer an easy, fast and cost-effective alternative to machining or molding complex soluble cores. When making patterns for RTV molding, the FDM parts often use soluble supports. After building the pattern, it is placed in a clean station, and the supports dissolve. This is advantageous when the pattern has difficult to reach cavities and pockets. A similar approach is used to make soluble cores. Instead of building the core in a Fortus, it is made from the soluble support material. After casting, the soluble support core dissolves and leaves the desired cavity in the urethane part.

PROCESS

The RTV molding process requires no modification to use the soluble cores. The molds are built and the parts are cast just as they would be if a hand-loaded insert were used. For illustration, a single-pour casting method and automated vacuum casting machine are depicted. This is one of many ways to build RTV molds and cast urethane parts.

An alternate, two-pour method of mold making is depicted in the “RTV Rubber Molding” application guide. This guide presents detailed descriptions of each step in the process that may be applicable to the single-pour mold building technique.

Supplies:
- Soluble supports
- Soluble supports cleaning solution
- RTV mold making and casting supplies

Tools and Equipment:
- Soluble support removal tank
- Vacuum casting machine (optional)

Figure 1: These hoses are examples of parts that need soluble cores since the RTV tool cannot be extracted from the internal passage.

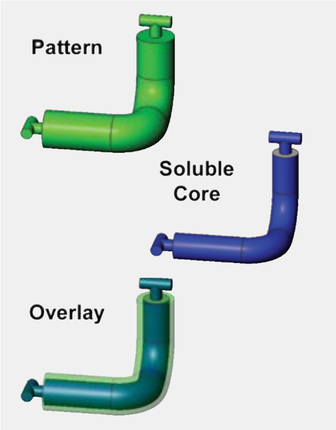

Figure 2: STLs of the pattern and soluble core for a radiator hose. The overlay shows how they are combined to form the internal passage.

PATTERN AND CORE DESIGN

For RTV molds that use soluble cores, two STL files are needed. One file is for the pattern and the other is for the core (figure 2). From the CAD data for the urethane casting, construct a 3D design of the soluble core. This will be an insert that defines the cavity in the urethane casting. To create it, perform a Boolean subtraction of the part's 3D data from a suitably sized CAD solid. Next, add locators to all points that can be extended out from the casting. These extensions, which are T-shaped in this example, locate and support the soluble core in the RTV mold.

To create the STL of the pattern, combine the part and soluble core. When RTV rubber is cast against this pattern, pockets that hold the soluble core's locators are formed. Export STL files for both objects and open them in the Insight build preparation software.

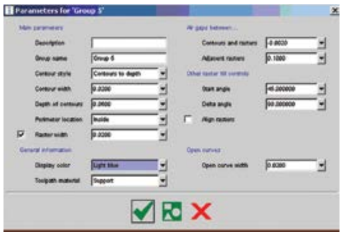

Figure 3: Insight custom group selection

PATTERN BUILDING

For pattern construction, use standard part orientations and build parameters. When the build is complete, remove the support structures and finish the patterns to the desired smoothness. Since the rubber molds will pick up very small details, it is import to smooth all surfaces to the quality level needed in the cast parts.

To expedite the finishing process, consider using the Finishing Touch™ Smoothing Station or solvent dipping if the pattern is made from ABS, ABSplus, ABS-M30 or ABSi. If constructed in PC-ABS or PC, consider solvent dipping. Next, use a combination of sanding, filling and priming to smooth the surfaces of the pattern.

Figure 4: A soluble core for the radiator hose.

SOLUBLE CORE PRODUCTION

The key to making soluble cores is to create custom groups in Insight that reverse the build and support material (figure 3). For the core, create a custom group that uses the sparse fill build style. This will allow the core to dissolve much quicker than if it were made solid. Use a large gap for the internal structure and create a slightly thicker exterior surface since the core will be subject to heat and pressure during casting. The recommended gap is 0.50 to 0.100 inch (1.3 to 2.6 mm). For a strong shell, add four or five solid layers as the outer surfaces are approached and use two perimeter passes for the outer contours. Finally, select the soluble support material for the toolpath.

For supports on the core, create a custom group that uses the toolpath material (E.G. ABS or ABS-M30) as the support material. Since each urethane casting will require one soluble core (figure 4), prepare a CMB file that makes all the cores, or the maximum that will fit in the machine, in one build.

Figure 5: The pattern is mounted on dowels and attached to the floor of the mold box.

MOLD BUILDING

Any method of RTV mold building will be suitable for a soluble core. For illustration purposes, the single-pour method is depicted in this process.

Begin the mold construction, by mounting the pattern inside of a mold box. In this example, the five-sided box is constructed from used FDM build sheets that are glued together (figure 5). The seams of the box are then caulked to prevent leakage of the liquid RTV rubber. Next, the pattern is attached to the floor of the mold box with dowels. Finally, dowels are mounted to the top surface of the pattern to form vents and a gate. These dowels are cut to a length that allows them to extend out of the cast rubber mold.

Figure 6: The RTV rubber is poured into the pattern and then allowed to cure.

Prepare a sufficient quantity of RTV rubber by mixing its components. Mix slowly to prevent introduction of air or plan on placing the mold in a vacuum chamber to remove air bubbles that may form on the surface of the casting cavity. After mixing, fill the mold box with RTV rubber (figure 6). Pour the rubber slowly and along the side of the mold box. Always avoid pouring the rubber directly onto the pattern.

Allow the rubber to cure. The cure time is typically 24 hours, but this depends on the RTV rubber used. After curing, the RTV rubber will be firm, yet flexible.

The next step is to extract the pattern from the mold. In doing so, the parting line will also be created. First, remove the sides of the mold box. Then with a sharp knife or scalpel, cut the rubber on all sides along the desired parting line. Since the pattern is not visible, a good practice is to mark parting line locations on the mold box before pouring the RTV rubber and transfer them to the cured rubber just after removal of the mold box plates.

After making an incision on all side of the mold, forcefully pry the rubber open and continue to cut deeper into the mold. Working around the mold, continue to pry and cut until the pattern is reached. When all sides are cut, continue to pry the mold open until it separates into two pieces and the pattern is exposed. Note: a jagged parting surface is desirable as it serves to locate the two sides of the mold in the correct position. Finally, extract the pattern from the mold (figure 7).

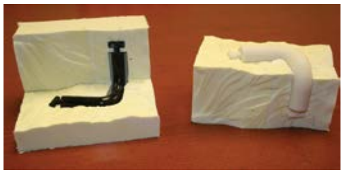

Figure 7: The finished RTV mold with the pattern placed in the mold (left) and soluble core inserted (right)

PART MOLDING

Insert a soluble core into one side of the RTV mold. Prior to closing the mold, spray both sides with mold release. Then, close the mold and tape it shut. The cast urethane parts can be gravity, pressure or vacuum cast. In this example, an automated vacuum casting machine is used (figure 8). Start the process by loading the two-part urethane material and placing the RTV mold in the machine. Then, attach the urethane dispensing tube to the mold's gate.

Start the vacuum casting cycle, which will mix the urethane, cast it into the mold and pull a vacuum to draw the material into the mold cavity. When the cycle is complete, remove the RTV mold.

Figure 8: The two-part urethane and RTV mold are placed in the automated vacuum casting machine.

PART FINISHING

Allow the urethane casting to cure according to manufacturer's specifications. Typically, this will be between 15 minutes and two hours. After curing, peel the mold open and extract the urethane casting, which will contain the soluble core (figure 9).

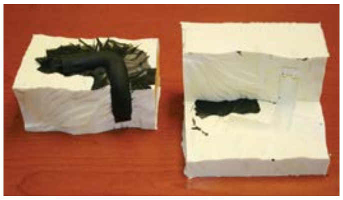

Figure 9: A urethane casting, with the soluble core, prior to extraction from the RTV mold. The black material on the mold's surface is flash from the casting operation.

To accelerate dissolving the core, cut off the locators that extend beyond the part's surfaces. Next, break up the core to allow the soluble support removal solution to come in contact with as much surface area as possible. If the urethane part is flexible, it can be bent, squeezed and twisted to crush the core. If the urethane is made from a rigid material, repeatedly poke a metal rod into the soluble core.

Place the casting (figure 10) in the soluble support removal tank and allow the core to dissolve. Depending on the size of the core and the volume of soluble support material, this process may take just a few hours, or it may need to soak overnight.

Figure 10: Finished hose part with soluble core in.

Remove the casting from the clean station, rinse and dry. The urethane casting is now ready to be put into service (figure 11).

Figure 11: Final hose-part

SUPPLIERS

Vacuum casting machine: MCP Group (www.mcp-group.com)

FDM PROCESS DESCRIPTION

Fortus 3D Production Systems are based on patented Stratasys FDM (Fused Deposition Modeling) technology. FDM is the industry's leading Additive Fabrication technology, and the only one that uses production grade thermoplastic materials to build the most durable parts direct from 3D data. Fortus systems use the widest range of advanced materials and mechanical properties so your parts can endure high heat, caustic chemicals, sterilization, high impact applications.

The FDM process dispenses two materials—one material to build the part and another material for a disposable support structure. The material is supplied from a roll of plastic filament on a spool. To produce a part, the filament is fed into an extrusion head and heated to a semi-liquid state. The head then extrudes the material and deposits it in layers as fine as 0.005 inch (0.127 mm) thick.

Unlike some Additive Fabrication processes, Fortus systems with FDM technology require no special facilities or ventilation and involve no harmful chemicals and by-products.

stratasys

E info@stratasys.com / STRATASYS.COM
ISO 9001:2008 Certified

HEADQUARTERS

7665 Commerce Way,
Eden Prairie, MN 55344
+1 888 480-3548 (US Toll Free)
+1 952 937-3000 (Intl)
+1 952 937-0070 (Fax)

2 Holtzman St., Science Park,
PO Box 2496
Rehovot 76124, Israel
+972 74 745-4000
+972 74 745-5000 (Fax)