POLYMER COMPOSITES, INC.

Silicone RTV Mold Making Basics **Technical Bulletin**

Silicone RTV Basics

Silicone RTV (room temperature vulcanizing) rubbers are high quality, two component synthetic rubbers that are the workhorse of modern prototyping and low cost parts replicating application. The advent of Silicone RTV was first applied to molding functions in the 1940's, and today it has evolved into a dizzying array of specialty molding rubbers. Silicone RTV resins have several advantages over most other molding compounds. Silicone RTV molds are suitable for high production operations because they offer excellent durability and stability. They are insensitive to UV degradation, can withstand high temperature exposure. It is resistant to water and most solvents. Once fully cured, Silicones have very little chemical interaction with most casting compounds. A big advantage of Silicone molds when it is constructed properly is it offers a very dimensionally stable and its ability to accurately capture minute surface details. It rarely requires a release agent to demold the cast part, which represents a considerable savings in time and money. Silicone molding resins offers an inexpensive and practical way of producing cavity molds for replicating just about any solid object.

MAX RTV 662 is one of the best resin compounds for tooling and mold making resins. It is comprised of a Platinum based catalyst that yields higher Durometer hardness for applications requiring greater dimensional stability, longer working times and superior mold durability. The MAX RTV 662 is a superior RTV molding resin capable of making large high detailed molds that is exceptional for reproducing thousands of parts. Although room temperature cured a short heat cure increases the dimensional stability and mold durability. MAX RTV 662 has a Shore Hardness of 66 A

Working with Silicone RTV

Silicone resins are inhibited by sulfur and amine bearing compounds. When creating a mold from a master part, it is important that the master part must be clean and is not made from any synthetic or natural rubber materials. Rubber typically contains Sulfur compounds, which are used as a vulcanizing agent to make rubber materials stable. A micro thin layer of uncured Silicone will be noticed on the master part due to the Sulfur's chemical inhibitive property to Silicone catalysts. The same phenomenon can be seen if the master part is contaminated with free amine compounds. Amine compounds are typically used as curing agents for epoxy resins and some types of wood will excrete a similar compound. So a master part that is constructed from wood or poorly mixed and improperly cured epoxy casted or coated parts are common causes of Silicone curing inhibition. To help reduce these types of problem, a liquid PVC parting film is usually applied on the master part and allowed to fully cure to a tack free film thus creating a barrier between the Silicone resin and the master part. The PVC parting film is water-soluble as is easily washed away form the Silicone mold and the master part. Another common source of inhibiting contaminants are latex rubber gloves coming in contact with the master part. Wearing protective gloves is always an excellent practice when handling chemicals but over handling of the master part with a gloved hand can lead to surface contamination. To remove the contaminant use a lint free cotton rag soaked in acetone or MEK solvent and wipe down the surface thoroughly as the last step prior to casting the Silicone resin mold. Avoid touching the Silicone resin and especially the catalyst with rubber gloves. Wipe any mixing utensils to be used in the molding process with the same solvent and rag procedure.

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Master Part Considerations

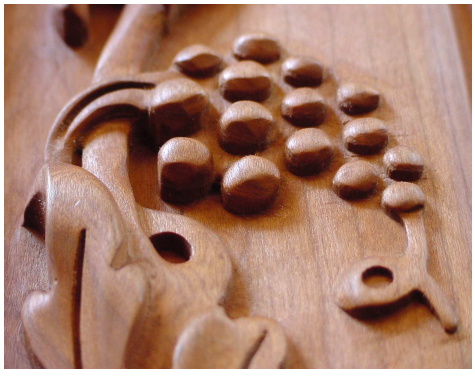
Silicone RTV resin has the ability to pick up microscopic details of the master part. The Silicone resin can replicate a 0.001-inch difference in the topography of the surface finish. Any small detail of the master part will be reflected as a reverse image on the mold and the subsequent castings will produce an exact replica of the master part. A glossy finish will produce a glossy mold surface and a matte finish will produce the same. Needless to say it is very important to consider the condition of the master part as far as its surface finish and the desired degree of detail that will be reproduced in the mold. Machined master parts are typically given a surface finish such as bead blasting to remove milling or machining marks and patterns. A surface topcoat is typically utilized to give the master part a smooth glossy finish. Other factors such as contamination from mold release agents and foreign materials should be also considered during the master part preparation.

The degree of under cuts and its relative angle also must be considered when choosing the molding technique and the cured hardness of the Silicone resin. Master parts that have complex angles and sharp under cuts or three dimensional molding will require a different molding technique such a two part molding or a split closed mold system. These techniques that will be discussed later and will require several more involve steps than the open face molding technique.

Open-Faced Cavity Mold Making Basics

Open-faced cavity molding is a simple and straightforward technique that can be used in casting any solid master part that has at least one flat side and minimal under cuts. The master part is temporarily affixed to a flat base then dammed on all sides to form a box. The Silicone is then poured into the box completely covering the contained master part and filled up to a predetermined volume. Upon cure of the Silicone RTV, the box is then disassembled and the cured mold is then demolded from the master part thus creating a reverse image of the master part in a cavity form.

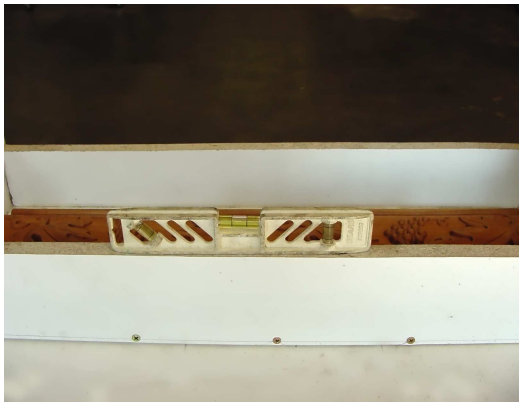
Here we will use a 24-inch long by 6-inch wide and 1 ¼ inch tall wood crown molding as our master part that has relatively ornate details. Since the master part has one flat dimension (back side) this makes an excellent candidate for an open-faced cavity mold. The master part has been sealed with our MAX SEAL water based varnish and then finish-sanded with a 1200 grit sand paper producing a semi-flat finish. The master part was then detail cleaned with a high-pressure air blast to remove any contaminants and loose materials. A very light coat of Silicone spray mold release was applied and then buffed with a lint free cotton rag.



Note the detailed carvings of the master part, which shows minimal undercuts and straight vertical walls. This master part will result in a cavity mold that will provide easy demolding and allow us to use a harder more durable Silicone RTV for a longer lasting Silicone mold. Also note the degree of surface preparation. Since we are creating a mold that is capable of producing hundreds of parts, a good attention to detail is important.

Next construct the box that will contain the master part and the Silicone RTV resin. The box can be constructed using common materials such as wood, metal or plastic. A good box building material is Lego®™ Building Blocks, which is easily constructed to any size, reusable and it is safe to use with Silicone RTV resins. For this project we used an MDF board with a Masonite face for our box material. The box must be large and tall enough so that a 1-inch minimum perimeter gap can be achieved around and over the master part. Depending on the size and shape of the master part, a wider gap is necessary for the length dimension of the master part than the width dimension. This will provide a more stable dimension lengthwise and it will prevent the mold from bowing in the center. Position and affix the master part on the base board and allow a minimum 1-inch perimeter frame gap measuring from the dam wall to the edge of the master part. This perimeter frame or gap will represent the wall thickness of the mold cavity. Note the wider gap running lengthwise versus the gap widthwise between the mater part and the dam walls.

To create a watertight seal between the base and the master part, apply a thin bead of hot melt glue resin on the edge of master part and press the master part firmly to the base to seal it. Use hot melt glue only to avoid cure inhibition of the Silicone RTV Use a sharp 45-degree angle blade to scrape or cut a clean sharp edge against the master part and the base plate. This will prevent the Silicone RTV from flowing between the base and the bottom of the master part and allow a flat and even surface. Apply the same sealing technique for the dam walls and secure with wood screws. When choosing an edge sealing material, avoid using caulking resins such as later or even Silicone adhesive since they contain compounds that will inhibit the cure of the Silicone Resin.



Next find an area where the box can rest undisturbed for at least 24 hours. Place the box on a level surface. Use a leveling tool to adjust the levelness of the box by shimming it with wedges and secure. This is a very important step; the Silicone resin will seek and settle to its own level plane and will cure to that level. If the box is not planed it will result in an uneven thickness from one corner to the other causing the mold and any subsequent casted parts to be uneven as well. This is especially important with large and long molds.

Now compute how much Silicone resin needed to use for the mold. As previously mentioned, we want at least a 1-inch minimum wall thickness all throughout of the cavity mold. Measure 1-inch from the thickest dimension of the master part and this will be the overall thickness of the mold. To obtain the amount of mixed Silicone RTV resin needed to make the mold, subtract the total cubic volume of the master part (length x width x thickest section of the master part) from the total volume of the box (length x width x overall thickness plus 1 inch) and multiply it by the density of the Silicone resin.
For example:
Volume of the Box Mold

Length =	26 inches	Volume= Length x Width x Height
Width =	9.0 inches	Giving us the equation:
Height =	2.25 inches (height of the master part + 1 inch)	*26 x 9 x 2.25 =* ***526.5*** *cubic inches*

When using an irregular shape master part, it is much easier to imagine the master part as a regular blocked shape. The resulting material overage will only increase the total thickness of the mold, which will be more dimensional stability.

Blocked cubic volume of the master part:

Length =	24 inches	Volume = Length x Width x Height
Width =	6 inches	Giving us the equation:
Height =	1.25 inches	*24 x 6 x 1.25 =* ***180*** *cubic inches*

526.5 – 180.0 = 346.5 *cubic inches of RTV Silicone*

Now we need to convert cubic inches to cubic centimeters. This will make it easier to determine the mass or weight of RTV Silicone resin needed since the density of the resin is expressed in grams per cubic centimeters (MAX RTV 662 = 1.28 g/cc).

346.5 cubic inches X 16.39 cubic inches/cubic centimeter = 5679.13cc

Now we take this product 5679.13 cc and multiply it by the density of resin 1.28 g/cc

5679.13cc X 1.28 g/cc= 7269.3 grams of mixed RTV Silicone resin needed

Given that the mix ratio for the RTV Silicone resin is 100 parts resin to 10 parts catalyst we need to calculate the amount of resin plus curing agent needed to sum up to ***7269.3 grams***. This is done by this equation:

Resin factor = parts catalyst (10) divided by 100 plus 1, so the equation will be:

1+(10/100)= 1.1

Now take this number and divide the total grams of mixed resin needed and we will get the total amount of resin or Part A needed, so the equation will be:

*7269.3/1.1=****6608.45 Grams of Resin***

Now take this number and multiply it by the percent of catalyst needed which is 10%, so the equation will be:

6608.45 X 10% = ***660.85 Grams of Catalyst***

6608.45 +660.85 = ***7269.3 grams***

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In a clean container weight out the correct amounts of resin and catalyst, typically mixing with a spatula or a mixing stick is recommended. Because of the volume of resin we will be using for this project, we will be utilizing a low speed mixer.

Attach a mixing blade to hand drill and mix at a low speed. Avoid mixing the Silicone too aggressively to avoid excess air entrapment. If available, degas the resin mixture using a vacuum technique to remove any entrapped air bubbles. Since the MAX RTV 662 has a four-hour working time, most of the air bubbles will release by it self. Mix until a uniform color is achieved and no color streaks are visible.

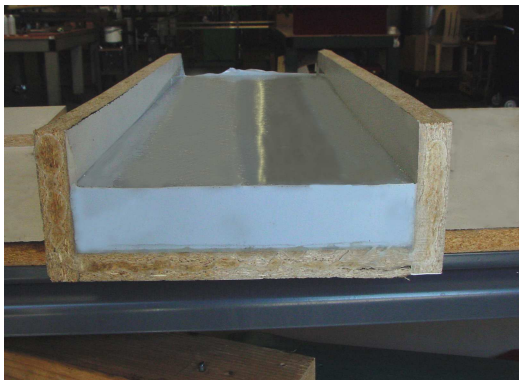
Transfer the entire mix into another container and continue mixing while making sure to scrape the sides and the bottom of the container with a spatula to insure that all the material is well incorporated.

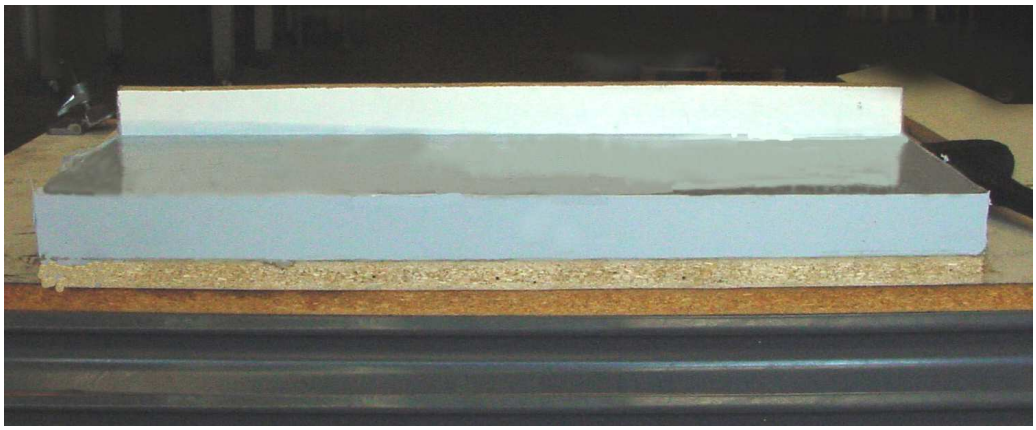
Mix for another 2 minutes under low speed and then allow the air bubbles to rise to the surface for about 10 minutes. Using the spatula gently stir out the surfaced air bubbles. Transferring the mixed material from the mixing container to another container will guarantee a homogenized and a uniformly mixed resin batch.

Now we are ready to apply the mixed Silicone resin to mold box. Since our master part is very detailed, we want to make sure that we capture all of the details without any defects caused by pockets of air bubble. An effective way of doing this is by pre-coating the master part with a layer of Silicone resin with a brush. Brush-apply the Silicone resin liberally directly on the design of the master part. Use the brush tip to aide the resin into the crevices, nooks and crannies.

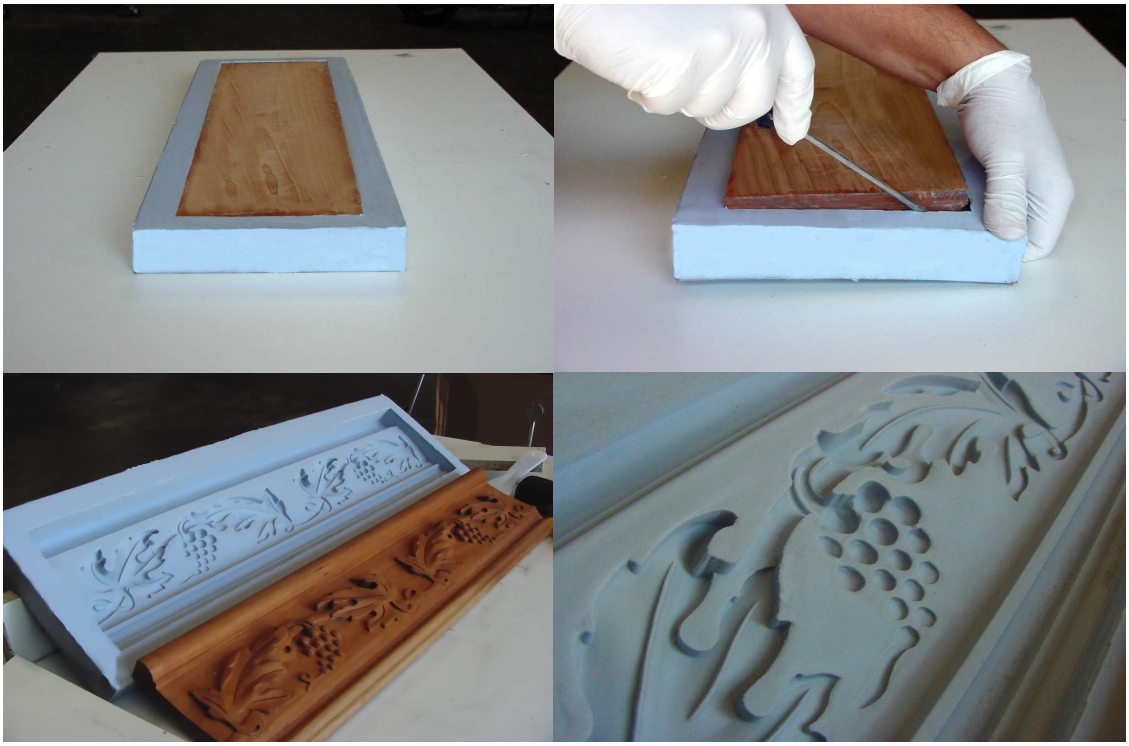
After brush applying the resin on the pattern, slowly pour the mixed RTV Silicone from one corner of the mold only. Pour consistently and do not move from the initial pour location, allow the resin to migrate and fill the box. If the box was properly leveled it will fill evenly from one side of the mold box to the other. Do not tilt the box but allow the resin to flow unaided. RTV 662 has a four-hour working time so it has plenty of time to settle to a level plane. To remove any stubborn surface air bubble, pass a hairdryer set at medium across the surface of the mold several times. This will help the air bubbles to pop. A propane torch also works very well for removing surface bubbles by performing the same procedure.

Allow the mold to cure undisturbed for at least 24 hours. Longer curing time may be necessary when curing below 70°F. After 24 hours, check the surface hardness of the mold. It should feel firm and tack free. If a Shore A Durometer Hardness tester is available, check the hardness, a 57 to 62 reading will indicate that it is ready for demolding.



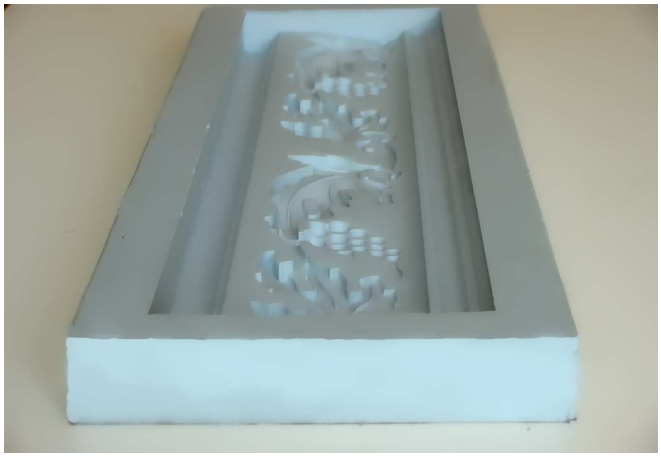


Carefully remove the end plates by gently tapping it with a rubber mallet. Cut away any flash material by running a razor blade or a pair of scissors level to the mold surface. Carefully pry off the side plates. In a corner of the mold gently peel back the Silicone mold upwards and away from the base plate. Use a flat blade screwdriver or plastic spatula to help pry the mold free.

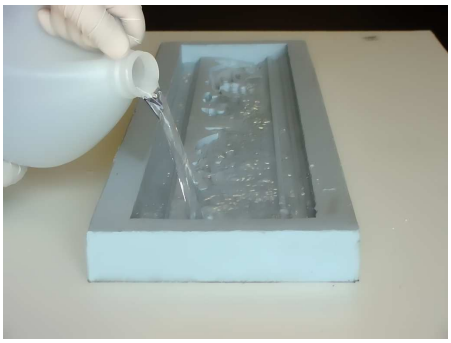


The whole mold should peel away from the base plate revealing the backside of the master part. Cut away or trim off any flash material that might have seeped in between the master part and the base plate. If the master part was properly sealed to the base plate, the mold should be level with the master part.

With a screwdriver, carefully pry away the master part away from the Silicone mold. The master part should easily break away and lift free from the Silicone mold. Inspect the mold for any defects such as air bubbles, which will show up as a cavity in the Silicone mold. Mixing a small amount of Silicone RTV resin and carefully patching the cavity can do small repairs. If done correctly the mold should be defect free because of the pre-application that was done with the brush.



To determine how much volume of casting resin is needed to fill the mold cavity, use water to fill up the cavity and measure the amount used. Since water has a density of 1.0 gram per cubic centimeter, the total cubic volume of the mold cavity is exactly established.



For example:

Fill a container with an estimated amount of water needed to fill the mold cavity and place it on a scale. Tare the scale to zero and pour the water in the mold cavity and fill it level with the mold. Place the container back on the scale and note the weight in grams. The total weight used is the same as the volume of the mold cavity in cubic centimeter. Then mark the mold with this number for future reference. The mold is ready for producing an exact replica of the master part.

For more information about MAX RTV 662 and other casting resin, please visit our website at

www.polymercompositesinc.com

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