

Silicone Mold Making

John Hutchinson for Hacksburg

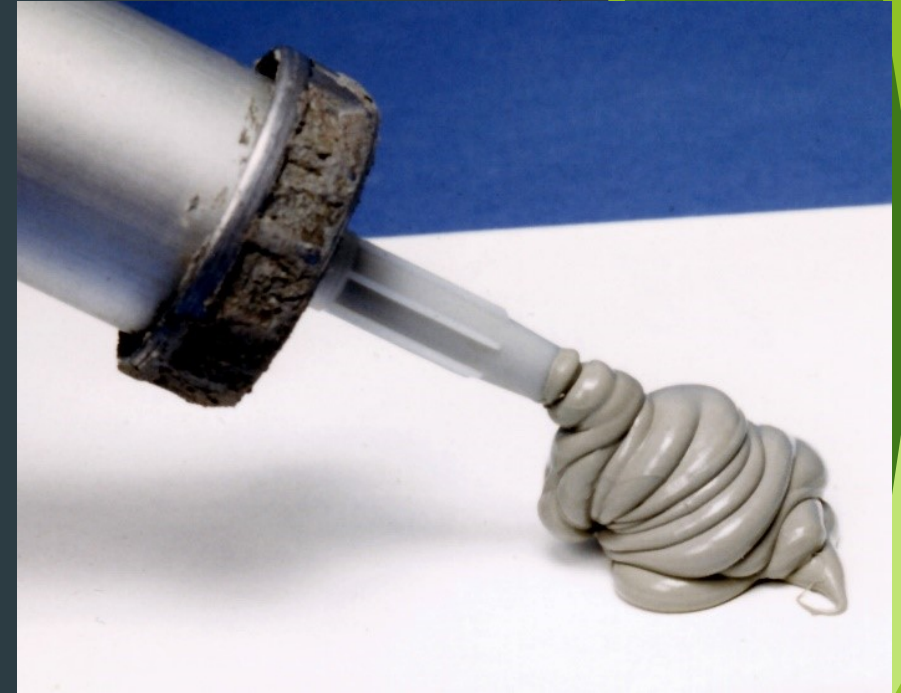
Agenda

- ▶ Silicone Mold Rubber
 - ▶ Commercial and DIY
- ▶ Mold Making Process
- ▶ Troubleshooting Common Issues
- ▶ Advanced Mold Making Techniques
- ▶ Additional Resources



Silicone

- ▶ Colorless, rubber-like polymer
- ▶ Ideal for casting many types of materials
 - ▶ Thermal stability: maintains strength and size from -100 to 250 °C
 - ▶ Non-stick properties: silicone only sticks to glass, silicone, and silica
- ▶ Food safe compositions can be used to cast chocolate, etc
- ▶ Max temperature of 500 °F (260 °C) limits it to low-temperature metal alloys



Commercial Silicone Mold Rubber

- ▶ Typically 2-part mixtures that are combined and poured over the part to be molded
 - ▶ Also available as putty that can be molded onto an object
- ▶ Tin cure: easy to use and significantly cheaper
- ▶ Platinum cure: less shrinkage and longer life
- ▶ Formulations available with different harnesses, viscosity, colors, etc
- ▶ Around \$20/pint for basic (tin) mold rubber



DIY Silicone Mold Rubber

- ▶ Uses commonly available silicone caulk as base
 - ▶ Additives improve cure time and strength
- ▶ Silicone caulk cures due to moisture in the air. By adding water we can speed up the cure process
- ▶ Resulting rubber is not pourable, more of a putty
- ▶ 2 main methods
 - ▶ Soap method
 - ▶ Corn starch method
- ▶ Around \$6/pint
 - ▶ All materials available locally



Soap Method

1. Fill a bowl with room-temperature water
2. Stir in approximately 1 part soap to 10 parts water until completely dissolved
3. Squeeze a tube of silicone caulk into the water
4. Knead the under the water until it is no longer sticky, about 5 minutes
 - ▶ Wear gloves during this process!
5. Form the putty into a thick disk against a flat surface
6. Press your model into the silicone and allow to harden a few hours



Cornstarch Method

1. Squeeze a tube of silicone into a bowl or dish
2. Add 1 part corn starch to 10 parts silicone
3. Add a few drops of acrylic paint
4. Knead together and until completely combined into a putty
 - ▶ Wear gloves during this process!
5. Form the putty into a thick disk against a flat surface
6. Press your model into the silicone and allow to harden a few hours



Modifying properties

- ▶ The consistency, strength, and dry time of the mold can be adjusted by adjusting the amounts of additives
- ▶ More cornstarch will make a stronger, stiffer mold with a faster cure time
- ▶ Adding thinner (mineral spirits, turpentine, or paint thinner) will make the mold more pourable, but increase the cure time
 - ▶ Excess thinner can cause the mold to shrink over time!
- ▶ For a pourable mold use:
 - ▶ 1 part silicone
 - ▶ 1 part thinner
 - ▶ A few drops of paint
 - ▶ A small amount of cornstarch



Mold Making Process

1. Select original model, “master”
2. Build a mold box, “containment field”
3. Prepare the model
4. Measure and mix mold rubber
5. Pour mold rubber
6. Wait to cure
7. Unmold

Original Model

- ▶ Can be made of virtually any material: wax, clay, plaster, stone, concrete, paper, metal, bone, fabric, etc.
- ▶ Silicone will only stick to itself, other silicones, silica, and glass
 - ▶ To mold a silicone object, release agents can be used
- ▶ Models with small details may require a thinner (less viscous) mold rubber
- ▶ Models with overhangs, undercuts, etc may require a 2-part mold
 - ▶ Small overhangs can sometimes be acceptable due to silicone's flexibility

Mold Box

- ▶ Prevents the liquid rubber from leaking out until it turns solid (“cures”)
- ▶ Small objects can use paint can, cake pan, Tupperware, etc
 - ▶ Remember, do NOT use glass or silicone
- ▶ If model is large or irregularly shaped a custom mold box may need to be built
 - ▶ Use a rigid plastic base and sheet metal, linoleum, or cardboard for the side wall
 - ▶ Foam board also works well
- ▶ Box must be liquid tight. Seal seams with clay, hot glue, or epoxy
- ▶ Mold box should be close to the size of the cast object to reduce waste



3D Printed Mold Box

- ▶ For 3D printed models, the mold box can be built into the printed part
- ▶ Most useful when several identical molds are required of a relatively simple model
- ▶ Ensure mold box has no overhangs. A slight draft may help with removing the mold
- ▶ In CAD, offset the model and extrude a solid base and walls
 - ▶ Walls must extend above the model, so may increase print time



Prepare Model

- ▶ Secure the model to the baseboard using silicone caulk, a glue gun, epoxy, or clay
 - ▶ Can also nail or screw the model to the baseboard, but this damages the model
- ▶ Porous materials (plaster, stone, concrete, wood, etc.) must be sealed using paste wax, petroleum jelly thinned with mineral spirits, or acrylic spray
- ▶ For porous models, drill 2 or 3 holes through the baseboard into the model to prevent trapped air from forcing bubbles in the rubber
- ▶ Apply a release agent to allow the model to be easily released from the cured rubber
 - ▶ Can use thinned petroleum jelly, mix of alcohol and dish soap, or commercial mold release
 - ▶ Spray cooking oil can be used, but must be thoroughly cleaned off
 - ▶ Use a thin, complete coat to avoid bubbles



Prepare Mold Rubber

- ▶ Follow manufacturer's directions
 - ▶ Some materials require precise mixing by weight, others are mixed by volume
- ▶ Mix the rubber completely for at least 3 minutes
 - ▶ Mix slowly and thoroughly to completely combined components and avoid air bubbles
 - ▶ Scrape the sides and bottom of the mixing container several times
- ▶ Most silicone rubbers have high viscosity and must use a vacuum chamber to remove bubbles for best quality
 - ▶ Some specific types of low viscosity silicone rubber do not require vacuum and may be better for beginners



Pour Mold Rubber

- ▶ Find the lowest point in the mold box and pour the rubber there at a slow, constant rate
 - ▶ Do not pour rubber directly on the model as this may entrap air bubbles
 - ▶ Let the rubber rise up and over the model to displace air from the lowest point
- ▶ Tiny air bubbles may rise and dissipate on the surface. These can be removed by lightly passing a hair dryer or heat gun over the surface



Cure and Unmold

- ▶ Wait for the mold to cure using the time specified by the manufacturer
 - ▶ Typically overnight (16 hours) at room temperature
- ▶ Curing can be accelerated by
 - ▶ Using a cure accelerator added during the mixing process
 - ▶ Applying heat around 150 °F (66 °C) after curing at room temperature for at least an hour
- ▶ Remove the walls of the mold box and the original model
- ▶ Post-curing the mold can improve the strength and abrasion resistance
 - ▶ Follow the manufacturer's instructions
 - ▶ Place the mold in an oven for 4-6 hrs at 150 °F (66 °C) and let cool to room temperature



Casting

- ▶ Your mold can now be used to cast copies of the original object.
- ▶ Some useful casting materials are
 - ▶ Epoxy and urethane resins: produce rigid plastic parts
 - ▶ Silicone: must use a mold release
 - ▶ Plaster
 - ▶ Soap
 - ▶ Wax: models can be used for lost-wax metal casting
 - ▶ Chocolate: must use a food-safe mold material
 - ▶ Low-melt metals: use a high-temp mold, contain a mixture of bismuth, lead, tin, cadmium and/or indium so take appropriate safety precautions

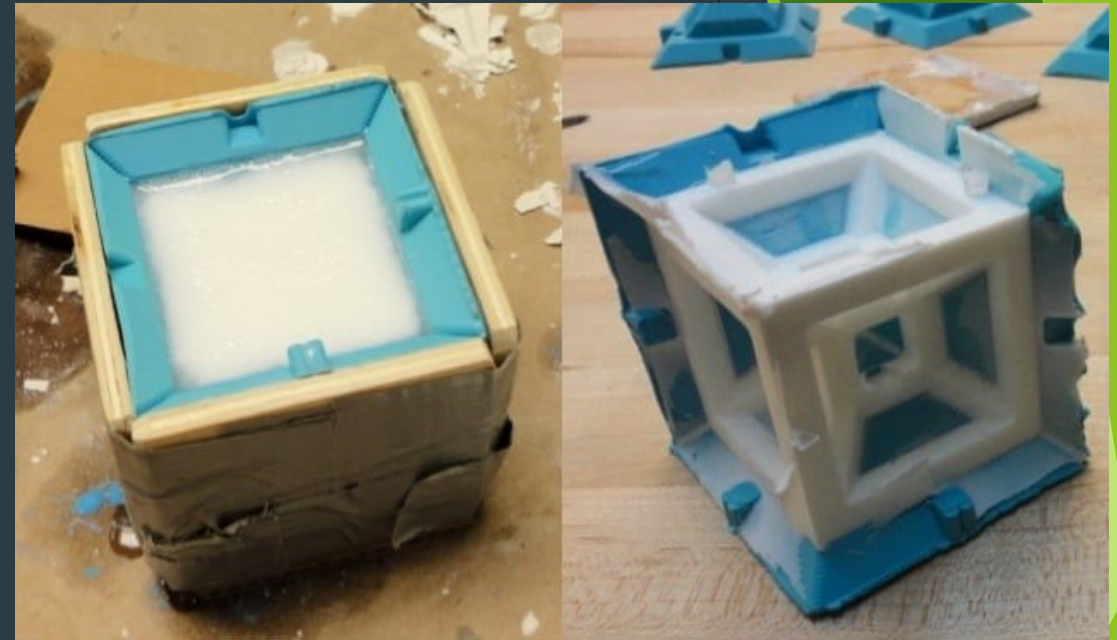


Common Troubleshooting

- ▶ Mold rubber did not cure at all (still liquid or gel-like)
 - ▶ Wrong mix ratio
 - ▶ For example, rubber was mixed 1A:1B by volume instead of by weight
 - ▶ Inaccurate scale
 - ▶ Room temperature too cold
- ▶ Partial cure (soft spots)
 - ▶ Not mixed thoroughly enough
 - ▶ Not accurate enough in measuring
 - ▶ Did not “pre-mix” either part A or B
 - ▶ Model was not properly sealed and released
 - ▶ Contamination can inhibit the cure of the rubber
- ▶ Mold rubber stuck model
 - ▶ Model was not properly sealed or released

Advanced Mold Techniques

- ▶ Models with complicated geometry (undercuts, overhangs, holes), large size, or not movable require different methods to produce a mold
- ▶ Some advanced methods include
 - ▶ Split, one-piece mold
 - ▶ Two-piece mold
 - ▶ Brush-on mold

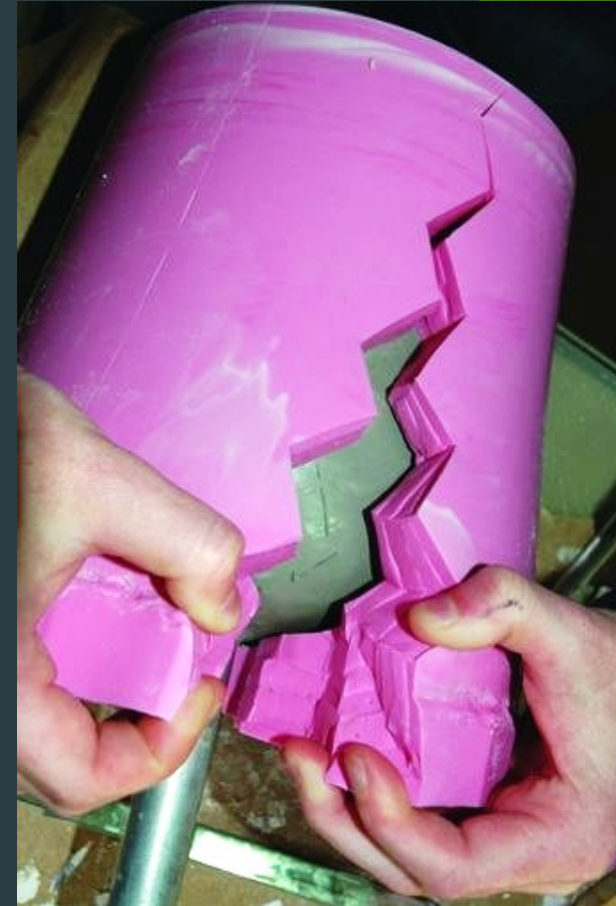


MULTI-PART MOLD

Complex shapes, with extreme undercuts or intersecting components, require a multi part mold that must be precisely engineered.

Advanced: Split, One-Piece Mold

- ▶ Models that are three-dimensional, having one long axis and one short axis, or those that are somewhat conical in shape without deep undercuts can be molded in one piece and cut with a razor blade or sharp knife
- ▶ Similar to previous prepare the model and mold box
- ▶ When pouring the mold rubber, tilt the mold box in all directions to move out entrapped air
- ▶ After curing and removing the mold box, use a razor knife to carefully cut the mold down one side and half way across the bottom
- ▶ Rubber bands can be used to hold the mold tightly together



Advanced: Two-Piece Mold

- ▶ For models with open spaces (e.g. legs to a base or between arm and torso), large undercuts, or reverse draft, a two part mold must be used to avoid “locking” the model in the mold
- ▶ First, identify the dividing line (parting line) where the two mold halves will meet. It can help to draw this line on the model
- ▶ Lay the model in the mold box and build up clay from the platform to the parting line
 - ▶ The model should be as level as possible and parallel to the base
 - ▶ When there are openings through the model, they must be “cored” by placing the center line midway between the top and bottom side of the opening



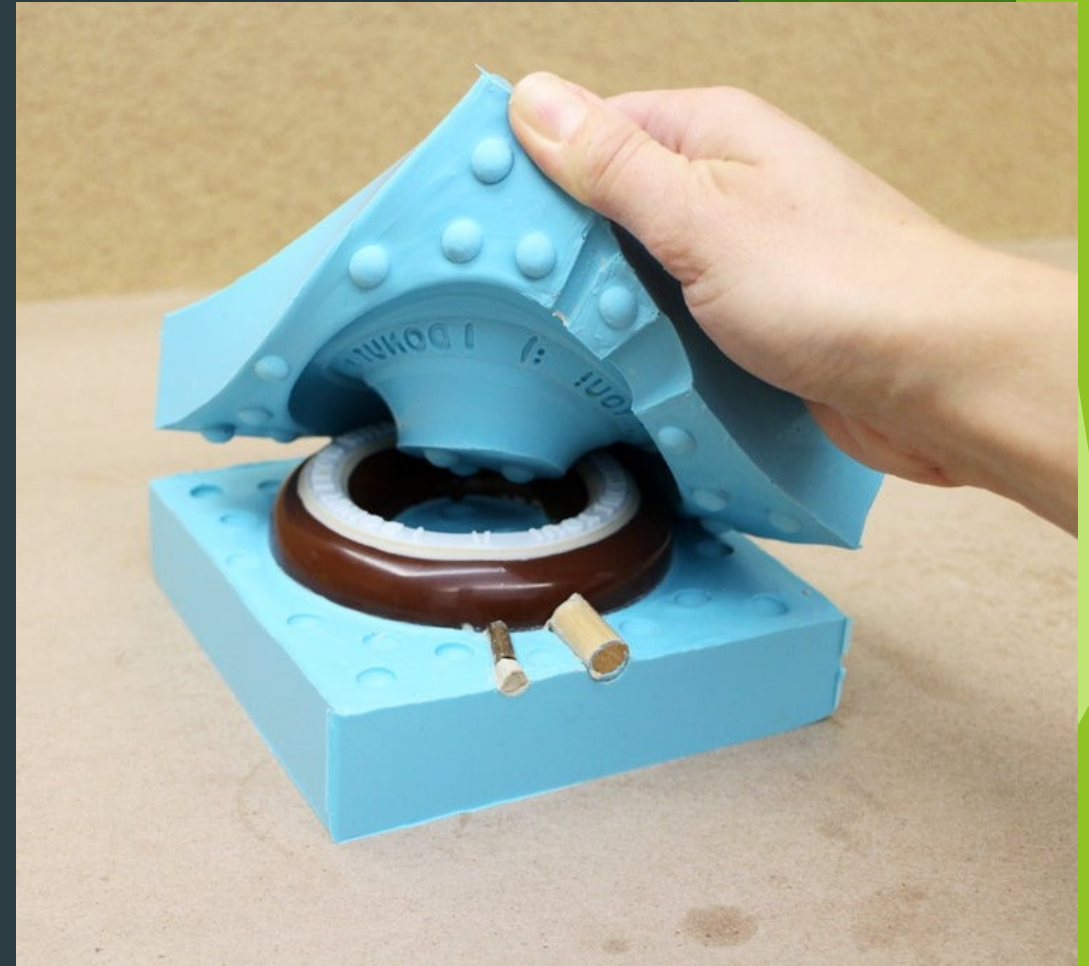
Advanced: Two-Piece Mold

- ▶ Smooth the top surface with fingers and alcohol or other solvent
- ▶ Add keys and/or a registration line around the perimeter of the model
 - ▶ Marbles can be used as registration or a rounded object can be pressed into the clay
- ▶ Mix and pour rubber as directed, making sure to have at least a half-inch of rubber over the highest point of the model
- ▶ Once cured, remove the side walls and all clay **without separating the model from the rubber**
- ▶ Thoroughly clean the side of the model that was embedded in the clay and remove any residual clay from the cured rubber.
 - ▶ If using physical keys, remove at this time



Advanced: Two-Piece Mold

- ▶ Place the cured rubber with model face up into the mold box making sure there is at least a half-inch above the highest point of the model
- ▶ Apply a release agent to the model and mold rubber
- ▶ Mix, pour rubber, and let cure according to directions
- ▶ After the rubber has fully cured, remove the model from both halves
- ▶ Assemble the mold by aligning the keys and use heavy rubber bands or straps to hold the halves together when casting



Advanced: Brush-on Mold

- ▶ Useful for large models or ones that cannot be moved to place in a mold box
- ▶ Prepare model as normal; clean and seal surface
- ▶ Apply a release agent to model and surroundings
 - ▶ Use a brush to ensure undercuts and fine details are completely coated
- ▶ Mix the brush-on rubber following manufacture directions
 - ▶ Add tint to every other layer to ensure complete coverage and avoid thin spots
- ▶ Apply a thin first coat to capture all details
 - ▶ Ensure complete coverage or mold can be ruined



Advanced: Brush-on Mold

- ▶ Wait for the first layer to become tacky, 30-40 minutes
- ▶ Apply a second coat using longer fluid strokes to build up the thickness, completely covering the model. Wait to become tacky
- ▶ Repeat for 3rd and 4th layers then wait for rubber to completely cure overnight (16 hours)
- ▶ Apply a support shell (to maintain the shape of the rubber when removed from the mold)
 - ▶ This can be a paint on plastic or more rigid rubber
- ▶ Cut the support shell and rubber mold away from the model along the parting line



Additional Resources

- ▶ Smooth-On
 - ▶ Manufacturer of mold rubbers, casting resins, and other supplies
 - ▶ How-To Booklet: <https://www.smooth-on.com/howtobooklet>
 - ▶ Tutorial website, may videos for basic and advanced techniques: <https://www.smooth-on.com/tutorials/>
 - ▶ Instructions generally reference Smooth-On products, but techniques apply to all brands
- ▶ Instructables
 - ▶ Soapy water method: <https://www.instructables.com/Worlds-easiest-silicone-mold/>
 - ▶ Cornstarch method: <https://www.instructables.com/Make-Your-Own-Silicone-Molds/>
 - ▶ Experiment with different ratios to meet your requirements
 - ▶ Two Part Molds: <https://www.instructables.com/Two-Part-Molds/>
 - ▶ Very thorough guide with lots of pictures
- ▶ 3D printer files
 - ▶ Corners for foamboard mold box: <https://www.thingiverse.com/thing:1778566>
 - ▶ Adjustable mold box: <https://silica.io/modular-mold-box-for-resin-casting/>
 - ▶ Laser-cut acrylic mold box: <https://www.thingiverse.com/thing:29844>