How to Make a Two-Part Silicone Mold

Jackie Song

Abstract
This guide will show you how to make a small two-part silicone mold from the object of your choice. You can use the mold for ice, chocolate, plastic, butter, or any material you can think of that plays nicely with the silicone you're using. For the Spring 2014 ME155 course, you will be required to cast your object in chocolate.To make this mold, you will make or obtain a mold positive (the object that you want to replicate) and pour a two-part liquid silicone rubber over it, once for each mold half.

Contents

1. The mold positive

The mold positive is the object you use to shape the silicone into the negative. If all goes well, all casts will be exact copies of the original positive.

1.1 Size and shape considerations

Silicone is forgiving and holds detail well, so your mold positive can be almost any shape or object you want. However, there are some important limitations you need to consider:

- For the Spring 2014 ME155 course, you will be limited to [this much volume of] silicone, which means your object should be relatively self-contained (which will also make it easier to mold). A good rule of thumb is to keep the object within a box of [these dimensions].
- Avoid undercuts (see Figure 1), which will make it difficult or impossible for you to remove your positive from the silicone. Depending on the thickness of your mold wall, the silicone can accomodate some stretch. Take a look at last year's molds (some of which are available in the lab), and use your good judgment.

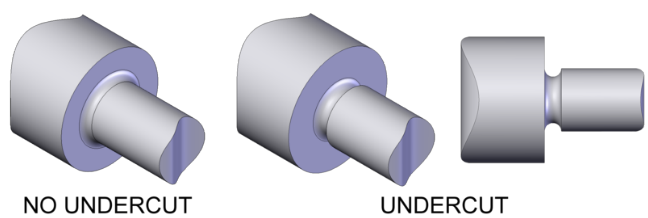

Figure 1. An example of an undercut in a part.

- Every two-part mold has a parting line (see Figure 2). The parting line can extend into a flat plane (for simple objects) or follow the shape of your object if necessary. Make sure you choose an object that lends itself to molding. Symmetrical, convex objects present the least difficulty.
- You need to choose one or more locations for a sprue and/or vents (see Figure 4). You will be relying on gravity to fill your mold, so choose wisely. Vents will probably not be necessary for this project.
- Consider how liquid will flow into your mold and harden later. Thin features might not fill properly. Air bubbles can get stuck in concave spots. Some materials expand or contract as they cool or harden.
- Consider the material you'll be casting from. Chocolate

Figure 2. Excess material indicates the location of the parting line.

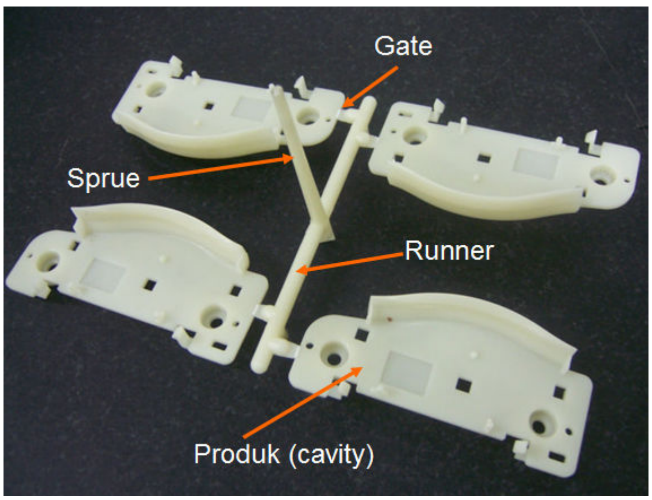

Figure 3. Material flows through the sprue before filling the cavity.

is fragile. Use your mechanics and materials science knowledge to avoid heartbreak.
- Silicone can hold very fine detail, but certain textures and features might not look very good in, say, ice. Again, use your judgment.

1.2 Sprue design

The sprue is the channel through which you pour the liquid casting material. It connects the outside of your mold to the inner cavity. If one surface on your mold is flat, you can omit the sprue and pour directly into the mold cavity (see Figure **??**). This can simplify casting in some cases, but it also makes your casts vulnerable to sloppiness from material overflow, which creates more work after your material hardens [see space shuttle overflow]. Make sure your sprue lies in the same plane as your parting line, so that it can be removed from the mold easily.

Figure 4. No sprue needed.

The sprue must be large enough in diameter to avoid flow obstruction by the capillary effect. Remember, melted chocolate is very viscous. The sprue needs to be built into the positive before pouring the silicone. It cannot be cut or pierced into the silicone after it cures. See [this figure] for examples.

1.3 Making the pattern

You have a number of options for making your positive. Here are some of the easier options available:

1.3.1 Existing object

If you have an existing object that works well for this project, all the better. Use something non-porous, and fill any holes [see this section].

1.3.2 Modeling clay

If you're good with your hands or clever with sculpting tools, you can use an oven-cure polymer modeling clay to make your positive. Super Sculpey, Premo, Kato, and Fimo work well for this, and they can be cured in any kitchen oven. Read the curing instructions very carefully, and make sure you know what temperature scale your oven uses (remember, the Thermolyne furnaces in the lab display in Celsius[1]). Do not use earth or oil based clays.

Using this method, you can easily include a sprue in the form of a dowel segment or similar object. Just insert it into the clay before you bake it.

Polymer clay takes well to finishing procedures like sanding, cutting, and drilling, so you can refine the shape further after curing. For example, this Sculpey ring (see Figure 5) was built in multiple stages of sculpting, curing, cutting, and sanding.

[1] Don't mess this up. The lab will smell terrible and you'll be responsible.

Figure 5. Sculpey engagement ring.

1.3.3 3D printing

Model your object in SolidWorks, Rhino, Inventor, or any software that can output `.stl` files. Include all sprues, so you won't have to glue them on later. See [this section] for guidance on sprue design. Keep in mind that the rough texture of the 3D printed piece will show up in your casts later, unless you smooth it out using sandpaper. 3D printed parts also tend to be slightly porous (between extruded lines), which can affect the texture of the mold.

1.4 Preparing the pattern

If you haven't already added a sprue to your positive, add it now. Then, make a final decision on where the parting line will be on your positive. If you want, draw it on in marker or pen; this will make the next steps easier. Try to keep it in one plane as much as possible.

2. Making the mold box

Once you have finalized the dimensions of your positive, you need to make a box in wihch to pour the mold itself. The box will have 5 sides, leaving one open so that you can pour the first half of the mold. Later, you will remove the opposite side of the box so that you can pour the other half.

2.1 Dimensions

First, determine the dimensions needed for your mold. If you can, avoid making thin outer walls in your final mold. To do this, design a mold box that leaves about .25in around the object on all 6 sides.

2.2 Materials

Acrylic pieces are a good choice for the mold box because they are easy to assemble and disassemble, and the cured silicone peels off easily. You can reuse mold box pieces from previous projects if you arrange them properly. You will need one piece for the base and four for the sides.

2.3 Assembly

If you're using old mold box pieces, and they're larger than you need, arrange them in a pinwheel pattern [see this figure] with the correct dimensions enclosed. Use hot glue to assemble the box. The mold box needs to be watertight at all joints, so run a bead of hot glue along the outside of every joint. Check that your box is watertight by filling it with water. Fix any leaks with more hot glue.

3. Preparing the mold box for pouring

3.1 Positioning the positive

In order to pour the mold in two separate sections, you need to position the positive in the box and block off all of the space past the parting line. Use an oil-based (non-drying) modeling clay to build up a wall on your positive on one side of the parting line (see Figure 6). Press the clay and your positive into the bottom of the mold box, leaving equal space on the sides and bottom of the model. Make the surface of the clay as flat and even as possible, using clay tools to push it around. There should be no gaps between the clay and the positive or between the clay and the mold box walls.

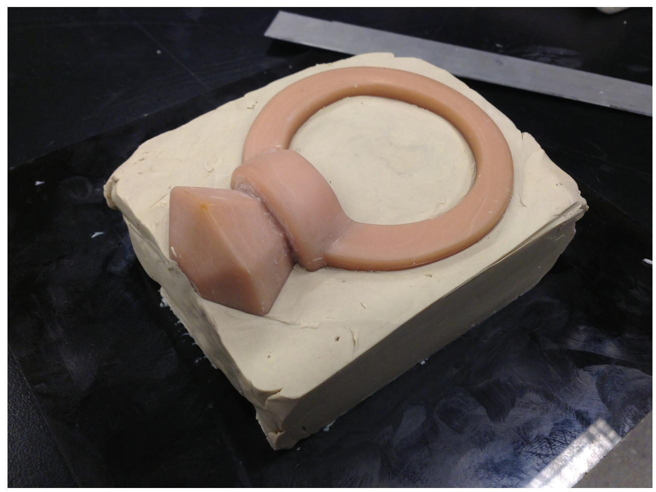

Figure 6. Oil clay built up to the parting line.

3.2 Alignment features

Alignment features are needed to reassemble the mold halves accurately later. Use a blunt tool end (or your fingertip) to press registration keys into the surface of the clay (see Figure 7). Make several, wherever there is space. To be effective, they should be at least 1/4 in wide and 1/4 in deep; as before, avoid making undercuts in the clay, which will make the mold halves impossible to separate.

3.3 Mold release

Using a mold release agent is very important if you ever want to retrieve your positive from the silicone. Use a mold release made for silicone. Following the manufacturer's instructions, apply it to the entire explosed surface of the clay and positive.

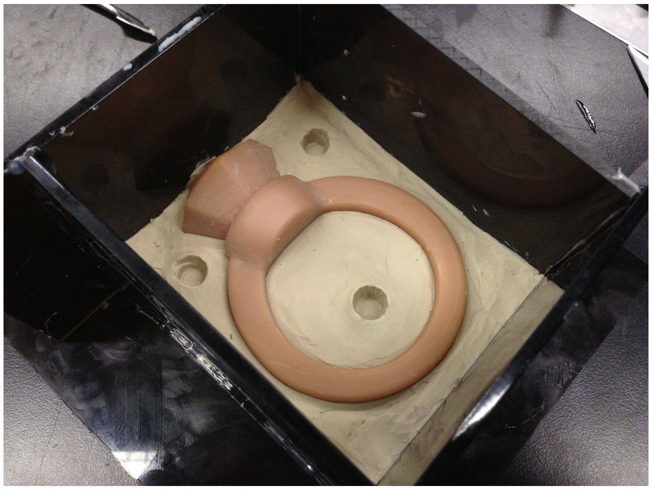

Figure 7. Registration keys pressed into the surface of the clay.

4. Creating the first half of the mold

You're finally ready to pour some silicone!

4.1 Measuring

4.1.1 Volume needed

Use the dimensions of your mold box and the approximate dimensions of your positive (and some math) to determine the volume of silicone you need. You can also pour water into the mold and then measure its volume with a graduated cylinder. You may need different volumes of silicone for each half of the mold, so measure carefully.

4.1.2 Weight needed

To make things a little more complicated, the two parts of the silicone mix need to be measured by a particular weight ratio. Check the packaging to find this value. You'll need a scale, a mixing container, and a mixing tool. The mixing container should be at least [this many times] larger than the volume of silicone, because it will expand in the vacuum chamber later.

Put the mixing container on the scale, then zero the scale. If your container is volumetric, use it to pour out the volume of silicone base you need. If it's not, determine the of silicone you need from its density. Now, note the weight of the silicone on the scale and calculate how much curing agent you'll need. Add the curing agent to the mixing container until the total weight reading is corrent. There is no need to measure each material in separate containers.

4.2 Mixing

The silicone needs to be mixed very well to cure properly. Follow the manufacturer's instructions on mixing time. Make sure you scrape the bottom of the mixing container. See [this video] to get an idea of the technique.

4.3 Degassing

At this point, if you have mixed the silicone thoroughly, it should be full of tiny air bubbles. Since the silicone has a short working time, there is no time to wait for the bubbles to rise to the surface. Degas the silicone, mixing container and all, in a vacuum chamber for [this amount of time]. Not all of the bubbles will pop; this is acceptable.

4.4 Pouring

Lay the mold box on a flat surface. Holding the mixing container a few inches above the mold box, pour a thin stream of silicone into a corner of the mold. Don't move the stream around; the silicone will settle into the mold features on its own.

4.5 Curing

The silicone will need at least [this much time] to cure completely. Leave it in the pressure chamber while it cures; this will minimize the size of any remaining air bubbles. Multiple mold boxes can be stacked in the pressure chamber with cardboard dividers between layers.

5. Preparing the mold box (again)

5.1 Exposing the other half

Peel off the base of the mold box to reveal the packed clay. Be careful not to damage the rest of the box. Remove all the clay from the mold box, leaving the mold positive embedded in the silicone (see Figure 8). Make sure to thoroughly clean the clay from the mold box.

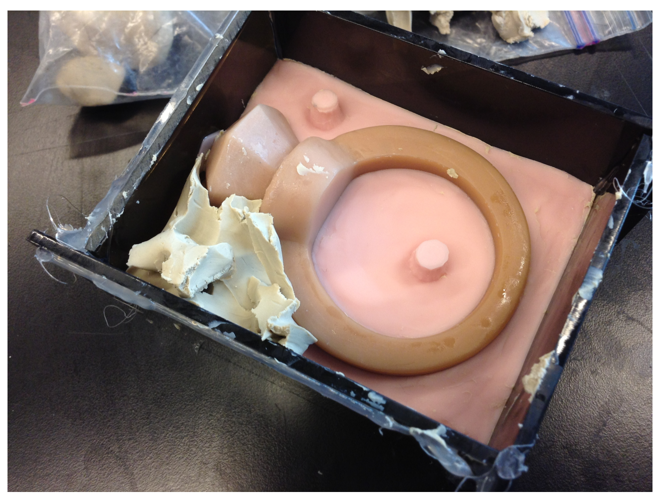

Figure 8. Peeling back the clay to reveal the first pouring of silicone.

5.2 Mold release

It is absolutely necessary to use mold release this time around; otherwise, the two silicone pieces will be nearly impossible to separate, except with a blade. Don't forget it!

6. Creating the second half of the mold

Repeat the procedure for measuring, preparing, pouring, and curing the silicone for the second half.

7. Finishing the mold

Peel the remaining sides of the mold box away from the silicone. Carefully separate the two mold halves from each other (see Figure 9). Be careful not to tear the silicone if any

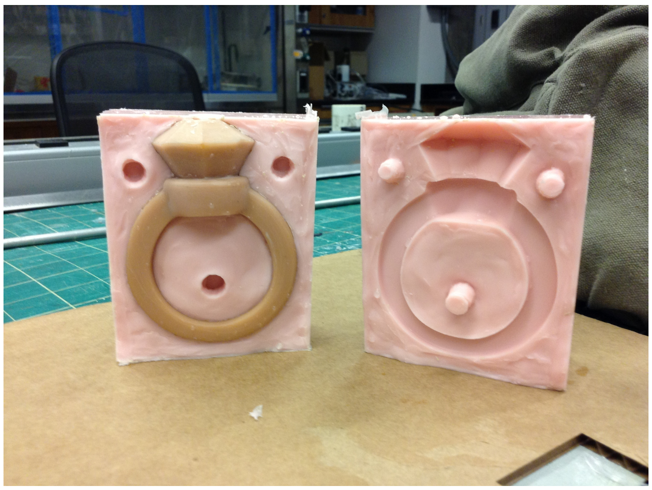

Figure 9. If all goes well, your mold should look something like this in the end.

parts have stuck together. Also be careful removing the mold positive from the silicone, and note any parts of the positive that are particularly difficult to remove; this will be useful for removing casts later.

8. Cleanup

Don't be a jerk! Clean up after yourself.

8.1 Silicone

Cured silicone should be peeled off of tools and thrown away. Uncured silicone can be cleaned with acetone nail polish remover. All mixing containers and tools should be cleaned.

8.2 Clay

Clay can be reused for future molding projects. Press it back into the original packaging.

8.3 Acrylic

Used acrylic pieces should be reused for future molding projects or reserved as scrap material. Clean them with soap and water and peel off any hot glue.