Vacuforming Plastic for Thin Castings

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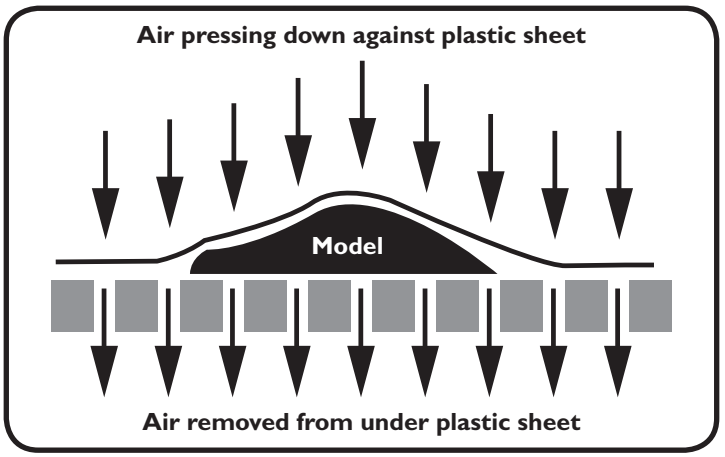
One of the limitations of hand carving wax forms for lost wax casting is the difficulty of creating forms that are light enough to be easily worn. The classic 'beginner's mistake" with wax is to forget that silver is 11 times heavier than wax. A seemingly weightless piece of wax can turn into something that feels like a boat anchor when cast into silver. Large forms are especially prone to this problem, as well as the difficulty of creating a wax object of consistent thin cross section.

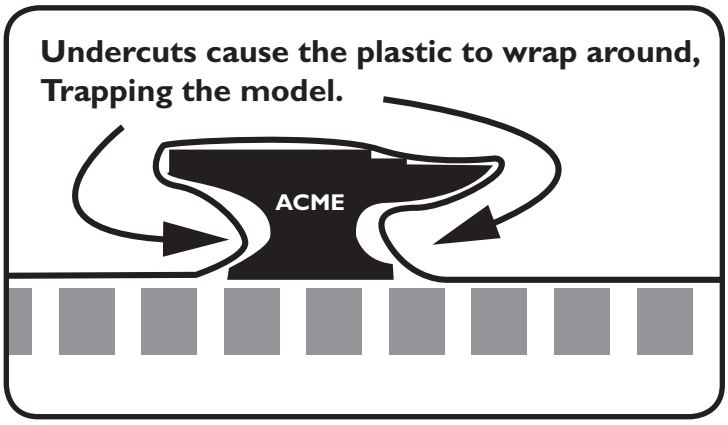
There are several ways of dealing with this problem, but one of the easiest is to forgo wax entirely. The object of lost wax casting is not the wax, it is the empty volume left behind in the investment when the wax melts and is lost. Keeping that in mind, any substance that will burn away completely can be used to create a volume into which metal can be cast. Twigs, bark, wood, paper, or some plastics are only the beginnings of the list of items that can be used.

This project will focus on the use of a vacuforming system to form thin sheet plastic into forms suitable for casting. The advantage to this system is that it is quick, and yields casting masters that are of thin cross-section, and therefore comparatively light. This process is also well suited to making duplicate or matching parts, as the original model is not normally damaged in the process, and can be reused indefinitely.

The drawback is that the system draws the plastic down over the item used as a model, rather like a rubber glove is stretched over a hand. This means that any detail on the original model is transferred to the plastic that will form the inside (back) of the finished silver. Small detail is therefore lost. This process works best with models that have large volumetric shapes, or that have large details that will withstand the softening of detail by the thickness of the plastic. Models should also be able to withstand a surface temperature of 400° F. for a few seconds, and about 15 PSI pressure. Delicate waxes or flowers would not be a good choice for models. A better choice for a master would be something made of wood, plastic or metal.



The basic idea is very simple. First one finds or creates some master object that is placed upon the vacuum table. Thin plastic is taped to a frame, and then heated in the kiln until it is soft and easily molded. At that stage, the plastic is removed from the kiln, placed onto the vacuum table, covering the master object, and then the air trapped underneath the plastic is sucked away through the vacuum table. The pressure of the air above the vacuum table then forces the molten plastic to stretch down against the master object, creating a 'skin' of plastic that exactly fits the master object. Once the plastic cools, it will reharden, and can then be cut out of the plastic sheet and finished to whatever degree is required. The finished plastic part is then sprued and invested as though it were wax. The invested part is then burned out and cast in the normal fashion. The final product is a cast metal part that is an exact copy of the plastic skin that encased the master object.



Procedure

Step One:

Find a model. It's going to be in contact with hot plastic, and pressure, so it needs to be strong. It is also going to have the plastic stretched around it on all sides. This means that it should not have undercuts, or it will be very hard to release the master object from the plastic once it has cooled. The forming plastic will cool very quickly, so the master object doesn't have to survive 400° F for more than a few seconds. Thus other plastic objects will work.

The object will be placed down on a flat vacuum table. Because of this, it is also best to choose an object with a flat side. Otherwise, the plastic will form around the sides of the object, and lock it into the plastic.

The plastic we will be using comes in sheets that are about 4 inches square. This is the maximum size that we can handle with this process. This is also roughly the maximum size of the centrifugal casting machine.

Step Two:

Pick a Plastic. The plastic comes in two thicknesses: thick and thin. The thick is .040" thick (Approx 18 Ga.). The thin is .020" thick (Approx 24 Ga.). The thick will be easier to handle, but the thin will transfer more detail to the front of the piece instead of trapping it on the back where it cannot be seen. Use the thicker plastic on volumetric forms without much detail. Use the thin plastic on items where detail matters. The thin plastic is so thin that it must be filled in with wax to thicken it during spruing. The thicker plastic can sometimes be cast directly without adding thickness, depending on the size of the piece. The larger or more detailed the piece, the more it becomes necessary to thicken it by adding wax to the back during spruing.

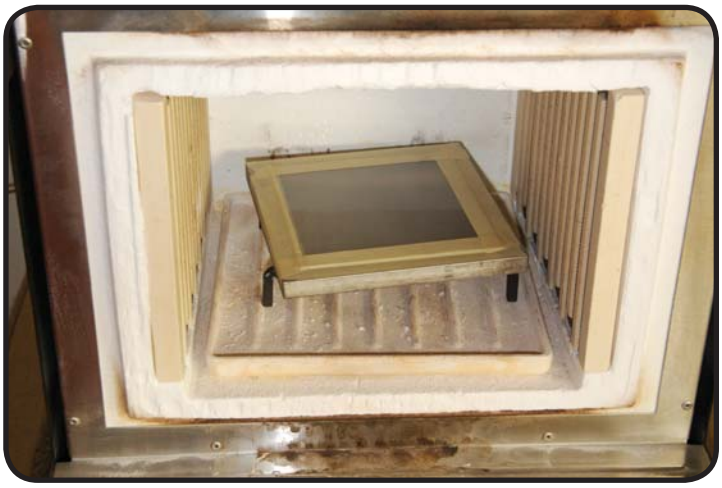
Another factor to consider is that the plastic will stretch during forming. The farther it has to stretch, the thinner it will be in the bottom areas once it gets there. Ask it to stretch too far, and it will simply rip. Equally, if it has stretched a good distance, even the thick plastic may be too thin to cast properly, and may require the addition of wax from the back. Pay attention to your plastic part once you cut it free of the plastic sheet. If in doubt, add a little wax.

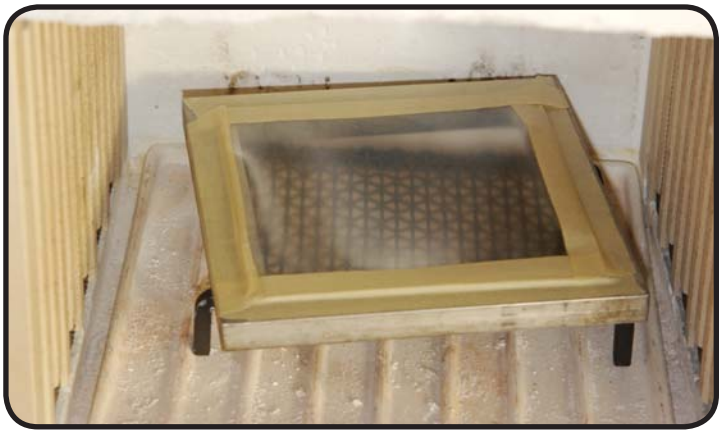
Step Three:

Get Framed. Find the aluminum vacuum frame. Place your plastic onto it, and use .75" wide masking tape to tape it in place. Make sure it is centered, and overlaps the frame equally on all sides. Tape along the complete length of all four sides. Try to keep the tape from extending out onto the area of the sheet that is not covered by the aluminum frame. If the tape does get out onto the open sheet, it can interfere with the plastic fitting itself to the model. Fold excess tape onto the edges of the frame, making sure that the tape is smooth. The surface of the tape will become your vacuum seal. If there are any wrinkles or creases in this surface, you will not develop maximum vacuum pressure, and your plastic will form less accurately.

Step Four:

Heat. The black electric burnout kiln should already be set to 400° F, and there should already be a steel enameling trivet inside. Using the blue welding gloves, place the plastic covered frame into the kiln with the plastic uppermost. Close the kiln door, and wait 2-3 minutes. Check the plastic periodically starting at 2 minutes. At room temperature, the plastic is milk-jug white. As it approaches molding temperature, it becomes clear, and starts to sag down into the frame. The 'not-quite-there' stage has it almost clear, and slightly wrinkled. When it becomes smooth, it's ready to mold. In any event, if the center sags down about .25", it's ready to go. Don't let it touch the trivet, or you'll get trivet marks in your piece. The thinner plastic will be ready more quickly.

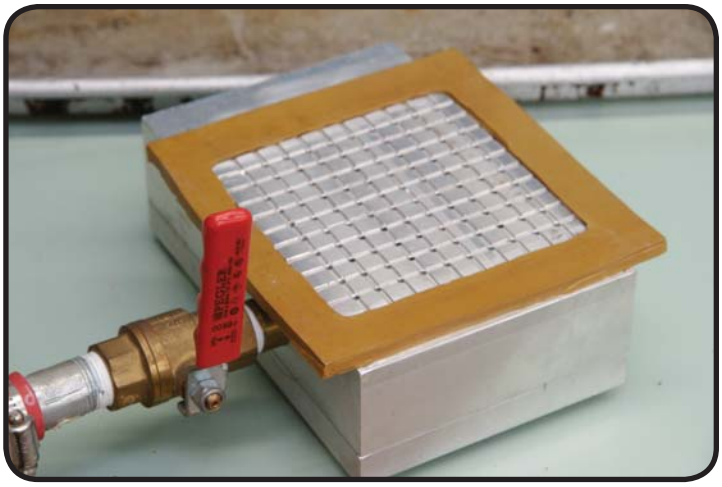




Step four-and-a-half:

Prep the vacuum system. While you're waiting for your plastic to cook, it's time to set up the vacuum system for forming. The vacuum forming box should already be attached and on the table. Make sure that the red valve on the box is in the fully vertical (closed) position. Bring the bell jar down onto the investing table, and close the red valve handle on the investing table to the vertical 'invest here' position. Once you think the plastic is 30 seconds from done, flip the switch to start the vacuum pump. Make sure the bell jar is down, and that the needle on the vacuum gage starts moving. The idea here is to pump the air out of the bell jar to give a little extra 'oomph' to the first, critical blast of vacuum.

The vacuum table can interfere with normal investing operation. If you wish to invest, make sure the valve on the vacuum table is in the fully vertical 'closed' position. Do not try to invest while people are actively trying to vacuform. Equally, do not try to vacuform while others are actively investing. Trade off, and make sure you pay attention to who else might want to use the equipment at the same time.



Step four-and-three-quarters:

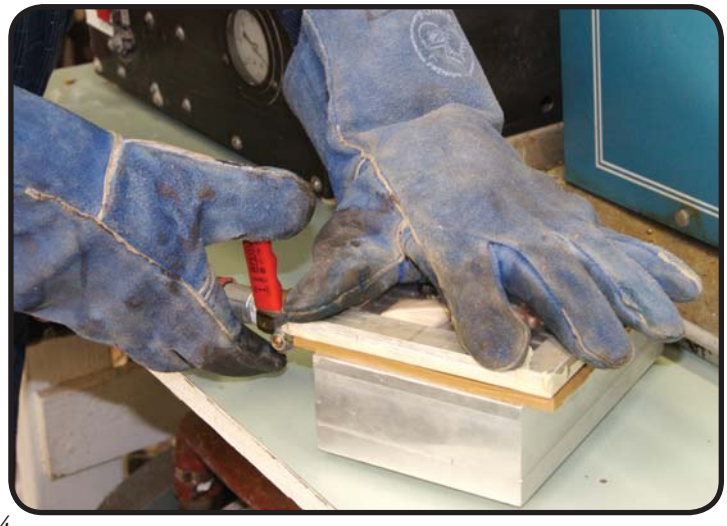
Place your master object onto the vacuum table. The table is 4 inches square. The chances are good that you can fit several objects onto it at once. Ask around the class to see if there is anyone else with a model ready that you could team up with.

Keep objects at least .25" away from each other, and at least .5" from the edge. Taller objects need more clearance.

Step Five:

Mold the plastic to your will. This is the fun part. Once the plastic in the kiln is clear and drooping about one quarter inch in the center, make sure the vacuum pump is running, and the vacuum gage reads somewhere in the 26+ range, Then use the blue welding gloves to reach into the kiln and grab the mold frame by the edges. Try not to touch the plastic. Time is critical here, as the plastic will start cooling the instant it comes out of the kiln. However, smoothness and accuracy are more important than haste.

Flip the frame so that it is tape-side-down, and press it down onto the top of the vacuum table. Make sure that it fits squarely around the grid of the table itself, then flip the red valve to the horizontal 'open' position while pressing down on the mold frame with your left hand. The idea is to get a good seal between the table and the frame. The better the seal, the more pressure the vacuum will place on the plastic, and the better the plastic will mold itself to your master.



Let the vacuum run for about 15 seconds, then shut off the pump. Open the vent valve on the investment table, and you should be able to remove the frame from the surface of the vacuum table. Your masters will probably come away with the plastic. This is OK.

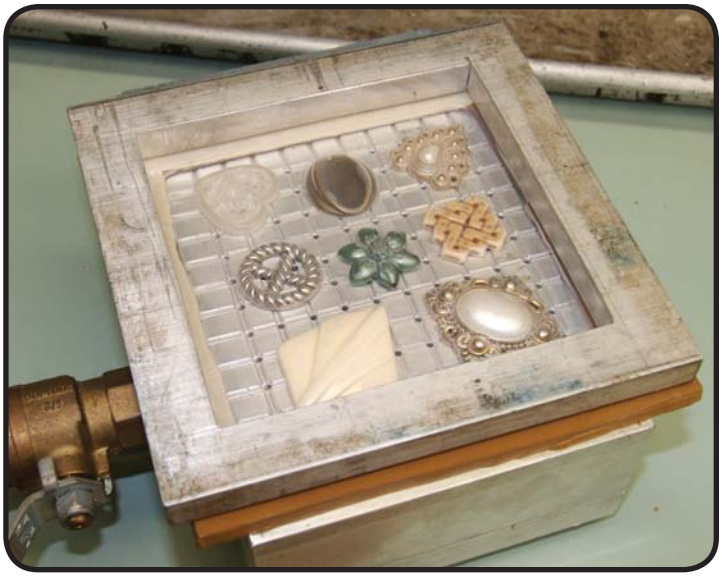
Step Six:

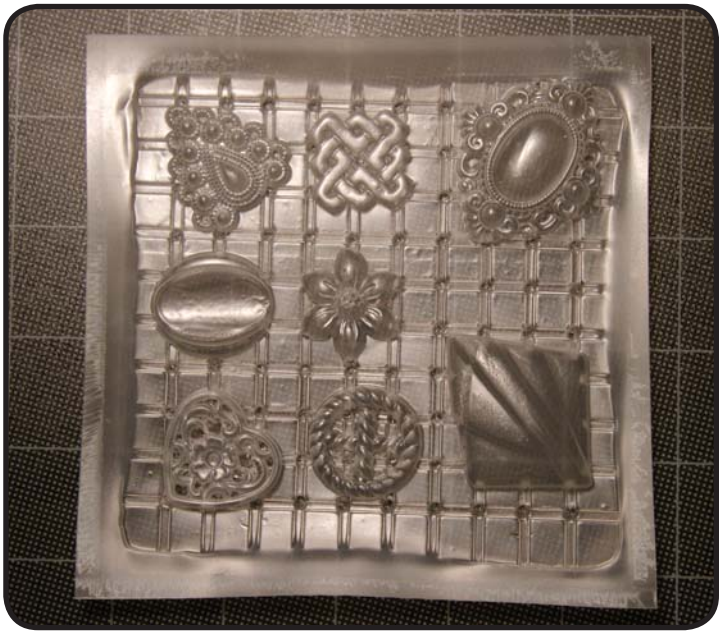
Clean up and cast. Once frame is off the table, continue to hold it with gloves. Remember: the plastic is thin, and cools quickly. The frame is aluminum, and does not. It's still nearly 400° F. You will receive a rude reminder of this should you forget. Strip the tape off, and remove the plastic. Quench the frame off in the sink. (not the blowout buckets. We don't want it covered in investment.) ***Do not leave hot metal laying around to surprise the unsuspecting.***

The plastic should be hard by this point. If there were several people with masters on the table, use scissors to cut up the sheet. Once the sheet is subdivided, use X-acto knives or scalpels to trim around the shape of the master. I find it helpful sometimes to try to use the flat bottom of the master to guide the scalpel blade around the form. Get the edge as clean as you can, using knives or other cutting tools. It seems to be easier to whittle down to the final form, rather than trying to force the knife to carve directly to the full form in one go. Safer too. Files and sandpaper seem to cause more trouble than they're worth. Final cleanup can be done in metal in any case. Jeweler's saws will cut it quite well, and can be used to cut out intricate shapes if necessary.

Spruing works just like normal, so long as it is remembered that the plastic part is thinner than a typical wax, and therefore needs sprues spread more widely around the backside to fill. If using thick plastic, take a look a the more stretched areas to see if they haven't gotten too thin. If they're under .035" (.89 mm), add a little wax from the back to reinforce them. If you used the thin plastic, add wax to the entire back. From that stage, sprue and invest as normal. Make sure you note 'plastic' on the investing form where it asks "what is it?" That way I know to set up the kilns to properly burn the plastic away.

A note about equipment: the instructions in this handout are tailored for custom equipment that I hand built based on systems already in place in the Wake Center jewelry lab. If attempting this on your own, you can purchase an 'all-in-one' system to do this from Rio Grande for about $400. ("Pro-Form Vac-U-Form, #700-658")





Note wax filling backside of plastic shape