Making a Master to Cast & Process for Casting It

October 6 2018: Jay Levy

What is "*casting*"? **Casting** is a manufacturing process in which a liquid material is usually poured into a mold, which contains a hollow cavity of the desired shape, and then allowed to solidify. The solidified part is also known as a **casting**, which is ejected or broken out of the mold to complete the process. https://en.wikipedia.org/wiki/Casting

Why cast? Process and concept – When creating jewelry, you consider casting if a piece is far too difficult to make with fabrication (metalsmithing) or when you want to produce many identical pieces using a reusable mold. Professional casters generally make castings faster and/or cheaper than you can. (fyi: Casters are lower paid than bench technicians or metalsmiths).

How is a model for a casting created?

Lost wax techniques are 5000-6000 years old with bee wax and clay used instead of wax. Apart from wax, your model can be anything that melts away clean.

Rules for working with Wax: None or few. Don't contaminate wax with things that don't burn out – e.g., not bones; Flowers and pine cones are castable "doable" but the cast piece may be too heavy. Styrofoam gives off formaldehyde, only floral green foam (Sternofoam) doesn't have formaldehyde.

All metals shrink, typically 5-7%, except antimony which expands. Therefore, make models for metal rings ¼ size larger. On average, make other models about 10% larger.

Edges are never clean on a casting. Consider rounding edges on outside and thin, carve out or fillet the inside. For rings, use a mandrel with an edge to size the ring blank. You can carve with a hot knife waxer to make a model, e.g. a ring from a ring blank.

There are catalogs of finished wax models. Plastic figurines of miniature animals may be used. Most burn out cleanly. Note: Bone, shell, claws, etc will not burn out.

Forming the master model: Jay showed examples of well-designed and poorly-designed models. Caveats: If the model is thin and long it is difficult to attach sprue wax to it and get a clean cast, or if the model is textured, it can't be textured all the way around. A smooth surface area is needed to attach the sprue wax. The problem with casting bugs or insects as models is that silver needs to flow into thin spots like the wings. Jay suggested casting the wings separately.

When making a model, the wax chunk is usually resized with coarser, heavier files or jewelry saw, then worked on with finer grade carving tools to bring out special contours and features. Elise noted that dry wall sandpaper is useful. A glue gun and wax rods were also mentioned as helpful aids in creating models.

Tools and Materials:

Types of waxes: The wax is really a form of a plastic called wax. It's a commercially prepared mixture. There are at least 6 colors of wax – 3 hard and 3 soft. In increasing order of hardness for hard waxes: Purple, green, and blue. In increasing order of hardness for soft waxes: pink, red sticky wax, bees wax (easy to mold). Wax comes in many assorted sizes and shapes: kits of different thickness slices, kits of wires (4 sizes) and 20 shapes including ½ round tubes and rods. Jay suggested finding sources for wax from other industries rather than the jewelry industry where the waxes are more expensive. When using wax be careful as all waxes can burn you except pink wax. Sprue wax is red tube wax.

Typical metals like silver, copper or gold have almost the same melting temperatures of 1500°F +/-. It is their color that makes them look different. Silver is the best for casting. Silver is an alloy. When silver is heated the lighter metal (copper) rises out of solution; it's called "firescale" and has a reddish or purplish hue. Copper rises out of solution when silver is melted or heated. To avoid discoloration, heat or solder quickly. When casting, melt quickly. **Dealing with Fire Scale - Ganoksin Jewelry Making Community**
https://www.ganoksin.com › Articles › Jewelry Making › Metal Forming

You can use water displacement to tell the difference between brass and gold (see Archimedes displacement experiment).

Centrifugal casting is/was used because the metals are highly conductive. Commercial casting is now done by vacuum, not centrifugal

One can carve wax and then use engravers to get proper sharp edges. One can safely use tools with an alcohol lamp, hot knifes, etc.

Files: Use old metal working files. Start with coarse and use full, wide swipes in one direction. Note: Be careful to smooth the model since scratches catch air bubbles.

Spruing, Investing, Burnout and Casting:

Making the investment is like using a “cookie baking” recipe. It requires the use of a balance scale and knowing the ratios of the amounts of water to powder to metal.

The process includes carefully weighing and recording the weight of the wax. Note: When casting silver, the wax is 1/12 gm of wt. of silver. Therefore, multiply the weight of wax x 12gm (for silver) to obtain the mass of silver you need to melt. Use a triple beam balance scale: for example, 1.6 gm in wax is the equivalent of 20 gm of silver (that will be needed to replace it when it is burned out).

Spruing and Investing a Formed Model

Sprue wax is red tube wax (thick). Jay recommended using 2-3 sprues/model. The sprue wax should have a lower melting temperature than the wax model. Sprues should be made from relatively wide solid tube wax. Note: The sprue is also attached to the wax base at the bottom of the investment canister or flask.

Placing sprues on a formed model

He used a kiln to burn out an investment with a sprued wax model that was invested a week earlier and kept in a bag with damp paper towel. A centrifugal casting machine was used to cast the lost wax investment. (For the workshop demo--- He suggested bringing ONE model to sprue and invest (to cast on a second session)

Investment – Can the investment go bad – yes, if you don’t follow the recipe, properly shape and smooth the model, and properly sprue the model in an appropriately sized flask. **The choice of the flask is important**. **Kerr, a respected** manufacturer of products recommended by Jay for casting has published the proper ratios to be used of casting powder, water, and canister size for a model.

Refer to **Investment Mixing & Burnout Instructions for Kerr Products** – 2 page handout is attached – refer to it as it is included in this handout.

Choose the smallest flask possible for your model: Due to the time available at Garvies (barely 4 hours) to burnout an investment, use the smallest shortest flask. The burnout for the small flask is 4 hours. Rather than 8-10 hours, or

more.

Mix powder and water for different flask sizes: Consider the size of the model or "piece" – with the piece sprued on bottom wax there should be clearance in the flask of > 1/4" on the sides and > 1/8th" from the top. Choose the flask/ e.g. 2 ½ in tall and 3 inches diameter requires 15 oz of powder to 170 ml of water. Or for example, 2 ½ diameter and 3 inches tall flask requires 12 oz of powder to 136 ml of water. Convert ml to oz and pour into large flask: weigh the empty flask and add the amount of water you need e.g. 170 ml water and add the amount of powder you need 15 oz powder as explained below.

For powder, the product sheet, gives the amount in oz. **To convert ounces (oz) to grams (gm) note that there are 28 gm/oz**. For the 15 oz of powder, multiply 15 times 28 and find you need 420 gm of powder. Weigh the empty bowl, into which you will put the powder; it weighs 110 gm. The weight of the bowl with the powder is a total of 530 gm on the scale. At first, set the triple balance beam scale to just under the expected total e.g. about 20 gm less than the total, 510 gm. Then change scale to 540 oz and add powder to bring balance to 530 gm.

For water, the product sheet gives the amount in ml. To convert milliliters (ml)) to grams (gm) note that there are 1 ml/gm. For the 170 ml of water, multiply 170 times 1 and find you need 170 gm. Weigh the empty bowl, into which you will put the water; it weighs 125 gm. The weight of the bowl with the water is a total of 295 gm on the scale. Note: **Add 10 gm of water or more to compensate for how much water is absorbed by the powder by sitting around**. At first set the balance beam scale just under (20 gm less than total) the expected total e.g. 270 gm. Then change the scale to 10 grams above 305 gm, or 315 gm, and add water to bring balance to 305 gm. When adding water, **the WATER MUST BE COLD**. Warm water sets faster. (Some add a bit of vinegar.)

The Kerr formula is set on their product sheet, but it may be adjusted. For instance, the powder at NMC/Garvies is old, and not properly kept dry. The powder vitrifies. You can adjust liquid to compensate for moisture in the flour or powder. Add more water to avoid clumping. A thinner liquid is better. Excess water floats to the top in the end. "*Mixing by eye is a sin." Jay Levy*

Coat wax model with soapy water: 1 part liquid soap and 9 parts water. The liquid soap reduces bubbles and helps provide a mold release. Mix the investment slowly by putting the flask on the vibrator on high for 2 (1-3) minutes eliminate

bubbles. Be sure to pour in the investment liquid (water and powder mixture) slowly down side of flask. The water and powder investment mixture should have the consistency of sour cream. As it is almost filled, add a bit on top, so there is a meniscus. Once it starts to dry and becomes a cheesecake-like consistency, use a straight edge (like a popstick) to slide off the top and write identifying information into the top. Carve your initials, the weight of piece in wax and in silver on top and the date.

Put in plastic bag with a wet towel to keep the investment moist until the day you do the casting.

Kiln Burnout and Investment casting

Centrifugal casting machine creates a force that is 6x the force of gravity to force the silver into the small places in the space in the investment created by burning out the wax model.

The Burnout uses a kiln with a 4 stage time-temperature schedule:

1) Up to 250 degrees quickly for the first hour to drive out the water without boiling the wax.
2) Then rise to 400-450 degrees to allow wax to melt in the second hour
3) Then rise to 800-900 degrees in 1-2 hours to allow wax to melt.
4) Then run up to 1500 quickly or in the next hour to bring to a temperature at which the silver melts and solidifies.

While the investment is burning out in the kiln, set up the centrifugal casting machine.

The arm of the centrifugal machine needs to be balanced. On one side of the arm is a weight, and on the other side of the arm is the crucible with the amount by weight of the metal to be used and the clip that will hold the investment and with a weight in the space for the investment flask that equivalent to the investments weight. The weight on one side of the arm that needs to be moved to balance the weight on the investment side.

There are different crucibles for each metal: silver, gold and base metals. The metals should never be mixed in the crucible. KEEP THE CRUCIBLES SEPARATE.

- Note: Never allow silver to come in contact with lead. If you subsequently solder the silver tainted with lead it will melt into a blob.
- Melt Flux in the crucible the very first time it's used. Flux is borax salt.

Set up the balanced arm by using an investment weigh with silver on one side of the

arm and move the weight on the opposite side of the arm until the arm is balanced; it teeter totters. Clean the silver to be melted for the casting in pickle first.

Always use the biggest torch to get the biggest flame to melt the cleaned silver and flux the silver with borax flux when heating the silver. It is recommended to use the proper glasses to protect your eyes. Use polycarbonate sodium flare glasses for glass working, like torchworked beads, or casting, when using a large torch with a large wide glaring flame.

Phillips Fitover Glassworking Safety Glasses - Polycarbonate Sodium Flare, #GB-SFP-33

$80.00

When setting up the centrifugal casting machines balance arm, WIND IT 6X clockwise and set the crucible side at 45 degree angle with the weighted side of the arm. Then, pull up pin to hold it in place.

Take the weight off the one side, that was measured to receive the investment.

Use gloves and protective prongs to remove the burnout investment from the kiln. Put the investment in the space on the arm in its propped position at 90 degrees from the crucible with the melting silver (it was opposite the crucible prior to winding and propping the arm in place before casting).

Use torch to melt the silver and when flowing release the pin and the crucible that is proximal to the investing flies (swings centrifugally) and shoots the silver into the investment.

Once the silver has been shot into the investment and it stops rotating. Take the investment out bracket holding it on the arm and Quench the investment by dropping it in a bucket of water. The plaster cast will break away and you will find the silver cast piece in the bucket of water.

References:

Jewelry Making by Murray Bovin
Centrifugal Casting by Murray Bovin
Investment Mixing & Burnout Instructions for Kerr Products – 2 pages included in handout – pages 7 & 8

Notes: by Barbara Kruger and June Miller, checked and edited by Jay

Investment Mixing & Burnout Instructions For Kerr Products

Instruction Steps


1. Weigh Investment

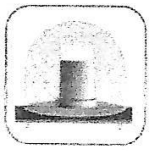

2. Measure Water

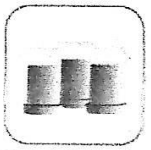

3. Always add investment to water

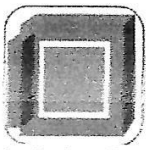

4. Mix 3-5½ Minutes


5. Vacuum for 20 seconds after starts to boil


6. Pour into flask

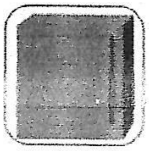

7. Vacuum up to 90 seconds.


8. Let flasks sit still for 2 hours


9. Preheat Furnace to 300° F / 149°C


10. Remove spruce base


11. Load into furnace


12. Follow burnout cycle

Powder & Water Requirements for Flask Sizes

Water / Powder Ratio: 40/100

First number represents investment powder (in ounces). Second figure represents water (in milliliters).

Diameter	2" tall	2½" tall	3" tall	3½" tall	4" tall	5" tall	6" tall
2"	5 oz. / 57 ml.	6 oz. / 68 ml.	7.5 oz. / 85 ml.	9 oz. / 102 ml.	10 oz. / 114 ml.		
2½"	8 oz. / 91 ml.	10 oz. / 114 ml.	12 oz. / 136 ml.	14 oz. / 160 ml.	16 oz. / 182 ml.	20 oz. / 228 ml.	
3"	12 oz. / 136 ml.	15 oz. / 170 ml.	18 oz. / 205 ml.	21 oz. / 240 ml.	24 oz. / 274 ml.	30 oz. / 340 ml.	32 oz. / 410 ml.
3½"	16 oz. / 182 ml.	20 oz. / 228 ml.	24 oz. / 274 ml.	28 oz. / 320 ml.	32 oz. / 364 ml.	40 oz. / 456 ml.	48 oz. / 548 ml.
4"	18 oz. / 205 ml.	23 oz. / 262 ml.	27 oz. / 308 ml.	32 oz. / 364 ml.	36 oz. / 410 ml.	48 oz. / 546 ml.	56 oz. / 637 ml.
5"					3½ lb. / 682 ml.	4½ lb. / 864 ml.	5½ lb. / 1000 ml.

Water / Powder Ratio: 38/100

First number represents investment powder (in ounces). Second figure represents water (in milliliters).

Diameter	2" tall	2½" tall	3" tall	3½" tall	4" tall	5" tall	6" tall
2"	5 oz. / 53.9 ml.	6 oz. / 64.6 ml.	7.5 oz. / 80.8 ml.	9 oz. / 97 ml.	10 oz. / 107.8 ml.		
2½"	8 oz. / 86.2 ml.	10 oz. / 107.8 ml.	12 oz. / 129 ml.	14 oz. / 150.9 ml.	16 oz. / 172.5 ml.	20 oz. / 215.6 ml.	
3"	12 oz. / 129.3 ml.	15 oz. / 161.7 ml.	18 oz. / 194 ml.	21 oz. / 226.4 ml.	24 oz. / 258 ml.	30 oz. / 323 ml.	32 oz. / 345 ml.

Diameter	2" tall	2½" tall	3" tall	3½" tall	4" tall	5" tall	6" tall
3½"	16 oz. / 172 ml.	20 oz. / 215 ml.	24 oz. / 258 ml.	28 oz. / 301 ml.	32 oz. / 344 ml.	40 oz. / 430 ml.	48 oz. / 5168 ml.
4"	18 oz. / 194 ml.	23 oz. / 247.9 ml.	27 oz. / 291 ml.	32 oz. / 344 ml.	36 oz. / 387 ml.	48 oz. / 516 ml.	56 oz. / 602 ml.
5"					3½ lb. / 645 ml.	4½ lb. / 817 ml.	5½ lb. / 946 ml.

Conventional Mixing/Working Time

Minutes 1-3 - Add powder to water & mix

Minutes 4-6 - Vacuum the mixing bowl

Minute 7 - Pour into flask

Minute 8 - Vacuum flask

Minute 9 - Top off flask

Minute 10 - Setting time

Minutes 11-12 - Gloss off

Vacuum Mixing/Working Time

Minutes 1-5 - Add powder to water & mix

Minutes 6-8 - Fill the flasks

Minute 9 - Setting time

Minute 10 - Gloss off

Casting Temperatures

Ladies rings - Filigree or intricate designs. 900° F-1000° F

Gents rings - Heavier designs. 700° F-900° F

During the last 1-2 hours of burnout, the temperature must be adjusted so that the flasks are at a correct temperature for casting.

5 hour cycle

2-1/2" x 2-1/2"
1 hour 300° F
1 hour 700° F
2 hour 1350° F
1 hour casting temperature

8 hour cycle

3-1/2" x 4"
2 hour 300° F
2 hour 700° F
3 hour 1350° F
1 hour casting temperature

12 hour cycle

4" x 8"
2 hour 300° F
2 hour 700° F
2 hour 900° F
4 hour 1350° F
2 hour casting temperature

Notes

Storage - Always store investment in a dry environment. After use, expel excess air from plastic bag and close lid tightly.

Mixing - The investment should always be added to the water in the recommended water/powder ratios.

Working Time - The work time is the time that has elapsed between adding the powder to the water, and when the investment thickens.

Water Temperature - Water should be 70° F- 75° F and should be measured with a thermometer to insure consistency. Colder water extends the work time, warmer water shortens the work time.

Investment Temperature - Investment should always be stored at the same temperature. If the temperature of the investment is warmer in the summer and cooler in the winter, the water temperature must be raised or lowered to compensate. Temperature of the investment should be periodically measured with a thermometer. Colder investment extends the work time, warmer investment shortens the work time.