How to Cast Using an Investment Mold

If you have plastic or wax objects that you want to use as the mold directly, skip to (creating wax tree) section. Otherwise, if you have an object is something that you want to keep intact, or is made of a material with a high melting temperature (eg metallic), move to the (injection wax) section.

INJECTION WAX INSTRUCTIONS:

Using the wax injector, you can very easily melt down wax, pressurize the container, and inject molten wax into a silicone, aluminum, or other mold to create a wax positive of your object to attach to the wax tree. Creating a mold can be done using any object and some silicon. Here are the steps

1. Grab your mold. Depending on the material, spray in some silicon release lubricant. Figure out a way to clamp it shut so there is no way in or out other than the injection hole.
2. Check how much wax is in the wax chamber by carefully unscrewing the clamps and sliding the top off. If it needs more, just throw any mixture of wax into it. When you screw it back on, make sure the washer is above the top plate, not below it.
3. Turn on the wax chamber to melt the wax. It shouldn't take too long to get some of it molten. Give it 5-10 minutes.
4. Attach the air hose to the orange nozzle inside the fume hood and turn on the orange air knob until the pressure gauge on top of the chamber reads some pressure, say $\sim 1 - 1.5\ kg/cm^3$.
5. Put on the wax covered work gloves and push your mold's injection hole into the front nozzle on the wax chamber. You will hear/feel/see it come out once you apply pressure. Take your object off once wax starts to leak out the front. Don't worry about getting wax on things when it splatters. It comes off most things well, including clothes [to a degree].
6. Set your mold aside for a while to allow it to cool. Depending on the thickness of your part, it can take up to 30 minutes to cool, or just three. You'll find out soon enough. Water submersion works very well for materials with high heat conductivity.
7. Crack open the mold to check out your wax part. Chances are it's either rad or incorrect.
8. Wash, rinse, repeat.

WAX TREE SECTION:

Materials Needed: the object(s) you want to cast, wax tree, sticky wax, perforated flask, plastic base, rubber circular grip


Perforated Flask


Plastic Base


Rubber Circular Grip


Wax Tree
(after Step 3)

1. Depending on the size of the object you want to cast, choose a suitable size perforated flask and a matching size rubber circular grip.
2. Obtain a wax tree. If the wax tree is too long for your flask, cut it.
3. Place the plastic base through the rubber circular grip and screw the tree on.
4. Using an alcohol lamp, heat the sticky wax, and use to secure your object(s) on the wax tree. (Note: This wax tree with the attached components is the shape that your cast piece will take, so do not create much surface contact between the tree and your objects).
5. You can attach multiple samples to the same tree, but do **not** let the different parts touch each other.
6. Place the chosen perforated flask onto the rubber grip. It should be a tight fit.
7. Ensure that there is enough space between the flask and the wax tree (and parts) on all sides.
8. Heat shrink the transparent (plastic?) sheet around the sides of the flask, so it is well sealed. The top (with the cross) should remain open.

MAKING THE INVESTMENT MATERIAL and DEWAXING MOLD:

9. Refer to Appendix A (Application Instructions: UltraVest) to make investment material for your mold and de-wax it afterwards in the furnace*.

***Note:** the Furnace time and schedule is dependent on the size of your flask, so ensure that you choose the right program.

ABOUT AN HOUR BEFORE CASTING:

10. Heat/melt metal in graphite crucibles to the casting temperature (specific to your metal/alloy).

CASTING:

Safety: Make sure you are wearing the safety shield helmet, blue coat, thick gloves (make sure these are NOT wet, and don't get wet), full pants, and closed-toed shoes.

11. Set up casting cart near a fume hood. Have a sand box close by.
12. If you plan to quench your material, keep a bucket of water nearby.
13. Turn on vacuum mode on casting cart
14. Bring perforated flask out of furnace using tongs. Place into the vacuum casting machine with the appropriately sized grip (for your flask) in place.
15. Pour metal (from crucible) into perforated flask using tongs to hold the crucible. While pouring the metal, ensure that the mouth of the crucible is well over the perforated flask so it does not spill outside.
16. Place empty crucible in the sand bath. Place the hot tongs in the sand bath as well.
17. When the metal solidifies (you'll be able to see a change in the substance from the hole on top), remove the flask from the cart.
18. If not quenching, skip to step 21.
19. place perforated flask (using tongs) into the bucket of water. Place gently.
20. Leave inside for 2-3 minutes. Then using your hands (rubber gloved), clean out the perforated flask and remove your casted piece. SHAKE IT!
21. Otherwise, if cooling slowly, place in sandbox. After it has cooled, clean out perforated flask and removed casted piece.

Your piece is made! Now, cut, grind and polish it.

Appendix A

Application Instructions
Ultra-Vest®
Jewelry Investment

UPDATED: MARCH 2005

For casting gold, silver, brass, bronze
& other low temperature alloys.

1. Referring to page 3, weigh the required amount of ULTRA-VEST investment.
2. Measure or weigh the required amount of water (1 g = 1 ml, 1 fluid oz = 29.6 ml) and place in mixing bowl.

   NOTE: Changes in temperature affect working time, to reduce variations water and powder temperatures should be held to 72-85°F (22-29°C). R&R recommends 72-75°F (22-24°C).

   Working time is defined as the time the powder is added to the water to the time the investment becomes thick.

   NOTE: Deionized water is recommended to maintain consistency of the working time.
3. Always add the preweighed quantity of investment to water. Adding the water to the powder will make it difficult to mix and will affect the working time.

   NOTE: If using a vacuum investment mixing unit, refer to page 2 for next steps.
4. Wet out the powder with a mixing paddle or a wire whip. This should take no more than 30 seconds.
5. Mix with mechanical mixer for 3 minutes. Good mixing is important to activate essential ingredients that make the investment perform to its fullest potential.
6. Place the mixed investment in a vacuum chamber and apply enough vacuum to cause a rapid boil. The investment should be vacuumed until it rises and breaks. Do not exceed 2 minutes. If a longer time is required, the vacuum pump is undersized, is in need of repair, or there is an air leak in the vacuum system.
7. Pour the vacuumed investment into and down the side of the flask. Avoid pouring it directly over the patterns to prevent wax pattern breakage.
8. Vacuum the invested flask about 1.5 minutes. Vibrating or tapping the flask during this operation will assist in releasing air bubbles from the pattern/investment interface. Release vacuum and fill the flask to the top of the metal edge. Do not overfill.
9. Immediately transfer the invested flask to a vibration free storage area. It is extremely important not to disturb the flask during the gloss-off phase as well as during the initial hardening process.

   ULTRA-VEST investment does not cause water marking; therefore, steps 3 through 9 may be completed in any time up to the maximum of 8.5 minutes.
10. Allow the investment to sit undisturbed for 2 hours. The mold will achieve its maximum green strength in 2 hours.
11. After hardening for 2 hours, remove the sprue base and investing collar.
12. Ideally, flasks should be loaded into a *preheated* burnout oven, button side down. Flasks should be elevated at least 1 inch above oven floor to allow proper air circulation and wax drainage. Do not place flasks too close to the heat source or to each other.

    NOTE: If loading into a cold oven 300°F temperature must be reached as fast as possible.
13. If steam dewax is used, transfer the flasks immediately from dewax into an oven preheated to 300°F (150°C). Do not allow flasks to stand at room temperature for more than 10 minutes.
14. Refer to page 3 and follow the wax burnout cycle suitable for your application.

    NOTE: Burnout cycles described are recommendations. Adjustments may be required for various furnace types, flask sizes and oven loading.

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Important Tips

1. Investment should always be added to the water.
2. Equipment must be kept clean and free of set investment.
3. Close the protective bag tightly in the container of unused investment and close the container when not in use.
4. Always store investment in a dry area.
5. Leave a minimum clearance from the patterns of 1/4 inch (6 mm) at the sides and 3/4 inch (19 mm) at the top and bottom.

PROCESS INSTRUCTIONS FOR VACUUM INVESTMENT MIXING UNIT

1. Follow steps 1-3 from above.
4. Mix with no vacuum on slow speed until the powder is completely wetted. Approximately 1 minute.
5. Start vacuum, increase mixing speed and mix for an additional 3 minutes.
6. Fill flasks under vacuum. Pour the investment down along the inside of the flask allowing it to flow up, around, through and over the top row of patterns.
7. After flasks are filled, continue to vacuum for 1.5-2 minutes. Vibration may be applied if available.
8. Continue with Steps 9 - 14 above.

NOTE: Total investing cycle should be completed within 6.5-8.5 minutes.

WARNING!

Contains respirable crystalline silica (RCS). Do not breathe dust. May cause delayed lung injury (silicosis, pneumoconiosis). The IARC (International Agency for Research on Cancer) reports (IARC Monograph 68) there is sufficient evidence in humans for the carcinogenicity of inhaled crystalline silica in the forms of quartz and cristobalite from inhaled crystalline silica in the forms of quartz and cristobalite from occupational sources. The NTP (National Toxicology Program) reports (Ninth Annual Report on Carcinogens) that RCS is known to be a carcinogen based on sufficient evidence from studies in humans indicating a causal relationship between exposure to RCS and increased lung cancer rates in workers exposed to crystalline silica dust. Follow OSHA Safety and Health Standards for crystalline silica. See Material Safety Data Sheet (MSDS) for detailed information.

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1. To determine the proper amount of water and powder to use per flask, locate the volume of the flask size you are using on the chart below.

CUBIC VOLUME BY FLASK SIZE							
Height—— Diameter |	**2.5 inches (6.4 cm)**	**3.0 inches (7.6 cm)**	**4.0 inches (10.2 cm)**	**5.0 inches (12.7 cm)**	**6.0 inches (15.2 cm)**	**7.0 inches (17.8 cm)**	**8.0 inches (20.3 cm)**
2.5 inches (6.4 cm)	12.3 in^3 (201 cm^3)	14.7 in^3 (241 cm^3)	19.6 in^3 (321 cm^3)	24.5 in^3 (400 cm^3)	29.5 in^3 (481 cm^3)	34.4 in^3 (561 cm^3)	39.3 in^3 (642 cm^3)
3.0 inches (7.6 cm)	17.7 in^3 (290 cm^3)	21.2 in^3 (348 cm^3)	28.3 in^3 (463 cm^3)	35.3 in^3 (579 cm^3)	42.4 in^3 (695 cm^3)	49.5 in^3 (811 cm^3)	56.5 in^3 (927 cm^3)
4.0 inches (10.2 cm)	31.4 in^3 (514 cm^3)	37.7 in^3 (618 cm^3)	50.3 in^3 (824 cm^3)	62.8 in^3 (1030 cm^3)	75.4 in^3 (1236 cm^3)	88.0 in^3 (1441 cm^3)	100.5 in^3 (1647 cm^3)
5.0 inches (12.7 cm)	49.1 in^3 (810 cm^3)	58.9 in^3 (965 cm^3)	78.5 in^3 (1287 cm^3)	98.2 in^3 (1609 cm^3)	117.8 in^3 (1931 cm^3)	137.4 in^3 (2252 cm^3)	157.1 in^3 (2574 cm^3)
6.0 inches (15.2 cm)	70.7 in^3 (1158 cm^3)	84.8 in^3 (1390 cm^3)	113.1 in^3 (1853 cm^3)	141.4 in^3 (2317 cm^3)	169.6 in^3 (2780 cm^3)	197.9 in^3 (3243 cm^3)	226.2 in^3 (3707 cm^3)

2. Using the volume located in the previous step, calculate the weight of powder and the volume of water for your flask size using the following equations:

HEAVY CASTINGS = 39/100 WP (Men's rings or pieces with thick sections)

English measure:

Volume (in^3) x .0455 lbs =_____ lbs powder Volume x .272 fl oz =_____ fl oz water

Metric measure:

[Volume (cm^3) x 1.25 g]/1000 =_____ kg powder Volume x .488 ml =_____ ml water

NORMAL CASTINGS = 40/100 WP (Ladies' rings)

English measure:

Volume (in^3) x .0448 lbs =_____ lbs powder Volume x .275 fl oz =_____ fl oz water

Metric measure:

[Volume (cm^3) x 1.23 g]/1000 =_____ kg powder Volume x .494 ml =_____ ml water

DELICATE CASTINGS = 42/100 WP (Filigree and small pieces)

English measure:

Volume (in^3) x .0435 lbs =_____ lbs powder Volume x .280 fl oz =_____ fl oz water

Metric measure:

[Volume (cm^3) x 1.20 g]/1000 =_____ kg powder Volume x .506 ml =_____ ml water

Wax Burnout Schedule

Flask size: up to 2.5 × 5.0 in. (6.3 cm x 12.7 cm)	**Flask size: up to 4.0 × 6.0 in. (10.2 cm x 15.2 cm)**	**Flask size: up to 6.0 x 12.0 in. (15.2 cm x 30.5 cm)**
Hold at 300F (150C) for 2 hours	Hold @ 300F (150C) for 3 hours	Hold @ 300F (150C) for 4 hours
Elevate to 1350F (730C) over the next 5 hours	Elevate to 1350F (730C) over the next 6 hours	Elevate to 1350F (730C) over the next 7hours
Hold at 1350F (730C) for 2 hours	Hold at 1350F (730C) for 3 hours	Hold at 1350F (730C) for 4 hours
Reduce to casting temperature & hold 1 hour before casting.	Reduce to casting temperature & hold for 2 hours before casting.	Reduce to casting temperature & hold for 3 hours before casting.

Note: Refer to the mold casting temperatures recommended by your alloy supplier.

Casting Defects: Potential Causes

POROSITY:

1. Pattern is improperly sprued. Sprues may be too thin, too long or not attached in the proper location, causing shrinkage porosity.
2. Not enough metal reservoir to eliminate shrinkage porosity.
3. Metal contains gas.
4. Mold is too hot.
5. Too much moisture in the flux.
6. Too much remelt being used. Always use at least 50% new metal.
7. Metal is overheated.
8. Poor mold burnout.

FINS OR FLASH ON CASTINGS:

1. Flask was disturbed while investment was setting.
2. Base was removed too soon.
3. Flask was allowed to partially dry before dewaxing.
4. Incorrect dewaxing or a furnace malfunction.
5. Flask burned out and allowed to cool below 500°F (260°C) before casting or reheating, or flask allowed to cool between dewax and placement in preheated oven.
6. Flask was improperly handled or dropped.
7. Speed was set too high on centrifugal casting machine.
8. Patterns were placed on one plane. They should be staggered on the top row.
9. Incorrect water powder ratio was used.
10. Not enough investment was placed over the patterns.
11. Flask was placed too close to heat source in burnout oven.
12. Flasks were not held at low burnout temperature long enough.

INCLUSIONS (FOREIGN PARTICLES) IN CASTINGS:

1. Patterns were improperly sprued to wax base or tree or not filleted, causing investment to break at sharp corners during casting.
2. Flask was not sufficiently cured before placing into burnout oven.
3. Improper dewaxing cycle was used.
4. Flask was not cleaned from prior cast.
5. Loose investment in sprue hole.
6. Molten metal contains excess flux or foreign oxides.
7. Crucible disintegrating or poorly fluxed.
8. Improperly dried graphite crucible.
9. Investment was not mixed properly or long enough.
10. Contaminants in wax pattern.
11. Flask was not held at low burnout temperature long enough.
12. Flask was placed too close to heat source in burnout oven.

ROUGH CASTINGS:

1. A poor quality pattern.
2. Flask was not sufficiently cured before placing into burnout oven.
3. Flask was held in steam dewax too long.
4. Metal, flask, or both, were too hot.
5. Patterns were improperly sprued.
6. Flask was placed too close to heat source in burnout oven.

BUBBLES OR NODULES ON CASTING:

1. Vacuum pump is leaking air.
2. Vacuum pump has water in the oil.
3. Vacuum pump is low on oil.
4. Investment not mixed properly or long enough.
5. Invested flasks were not vibrated during vacuum cycle.
6. Vacuum extended past working time.

SPALLING – WHEN AN AREA OF THE MOLD WALL FLAKES INTO THE MOLD CAVITY:

1. Flask was placed into a furnace at low temperature (below 300°F or 150°C) for an extended period.
2. Flask was placed too close to the source of heat.
3. Sharp corners are struck by metal at high centrifugal velocities.
4. Improper burnout cycle was used.

NON-FILL OR INCOMPLETE CASTINGS:

1. Metal was too cold when cast.
2. Mold was too cold when cast.
3. The burnout was not complete.
4. Pattern was improperly sprued, creating turbulence when casting in a centrifugal casting machine.
5. Centrifugal casting machine had too high revolution per minute.

GROWTH-LIKE ROUGH CASTING THAT RESISTS REMOVAL IN PICKLING SOLUTION:

1. Burnout temperature too high.
2. Mold temperature was too high when casting.
3. Metal temperature was too high when casting.

SHINY CASTINGS:

1. Carbon residue was left in the mold, creating a reducing condition on the mold surface.

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