



# Introduction to Casting for 3D Printed Jewelry Patterns

The way jewelers work is changing, and castable photopolymer resins are leading the way. From independent designers concepting and prototyping in their studios, to casting houses increasing capacity and diversifying their offerings, digital fabrication techniques are increasingly key to growing a successful jewelry business. In this guide, learn how to cast fine jewelry pieces from patterns 3D printed on the Form 2.

[Request a Sample Part 3D Printed in Castable Wax Resin >](#)

[Learn About Casting and Jewelry Production from Formlabs >](#)

## What Is Direct Investment Casting?

Direct investment casting, or lost wax casting, is a popular moldmaking technique that can be used to fabricate small and large parts in a wide variety of metals. Originating over 5,000 years ago, casting enables creators to work with a wide variety of materials and is one of the easiest ways to make metal parts.

In investment casting, a hollow mold is created from a hand-sculpted or 3D printed master pattern. The master is immersed in a refractory casting material (or “investment”), which dries and hardens. The wax or 3D printed pattern is burned out, leaving a negative mold of the design. Metal is poured into this hollow cavity to create the final part.

Wax patterns for intricate jewelry are complicated to produce by hand, and in a world driven by high demand and fast fashion, it can be difficult for hand-crafted pieces to keep pace. Advanced materials and affordable in-house 3D printers like the Form 2 are changing the way jewelry manufacturers and designers work, bringing industrial quality to the desktop and making it easier to produce and fit complicated geometries that once required hours of meticulous labor.



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## Essentials

### Made by Formlabs

- Form 2 (SLA) 3D Printer
- Castable Wax Resin or Castable Resin
- PreForm software (free)
- Finish Kit or Form Wash
- Form Cure

### Made by Third Parties

- R&R Plasticast with BANDUST investment
- Furnace (732 °C or 1400 °F), vacuum investment machine, and casting system such as Neutec J2R
- Alternative curing solutions: Gesswein UV Curing Chamber
- Surfactant coating such as Wax Wash from Gesswein

# 1. Design for Casting

Use CAD software such as RhinoGold, JewelCAD, or 3Design to take your parts from concept to 3D printed pattern using these best practices.

Design of traditional wax patterns and 3D printed resin patterns share many principles, such as the importance of smooth material flow. Where possible, avoid creating sharp corners that could increase turbulence. As with wax, orient the design so that it fills from larger voids to smaller channels and features.

## SPRUES

While large feed sprues can be created with normal wax, small sprue channels may be 3D printed to save labor and improve mold fill to areas of fine detail. Design feed sprues that are either straight or taper down towards the piece.

Supports added in PreForm should not be used as sprues. If you intend to 3D print sprues, we recommend incorporating them into your CAD design.

## FILIGREE

The exceptional detail of Castable Wax Resin allows you to create pieces with intricate filigree. These fine meshes of wires are challenging but possible to cast with careful sprue design.

Fine meshes can be printed with a [wire diameter as thin as 0.3 mm](#). Printed filigree is fragile and easily damaged by support removal. Design filigree parts to be as self-supporting as possible. 3D printed sprues may serve a dual purpose as supports that are removed after casting.

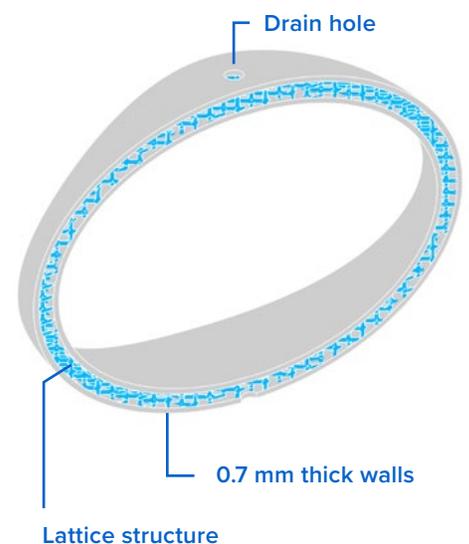
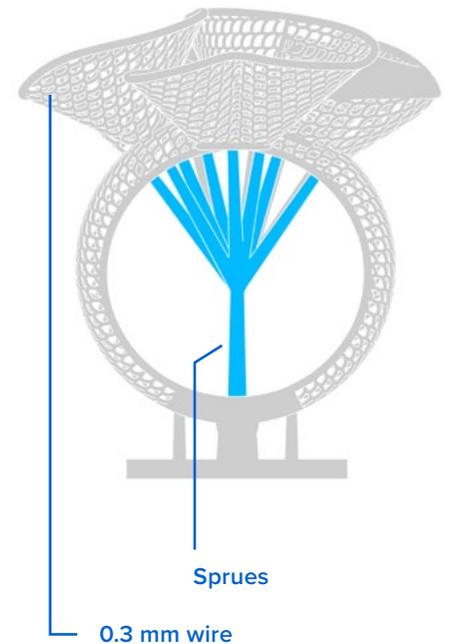
To avoid metal freezing in these thin channels, add sprues that feed metal to many points on the rim of a filigree mesh.

## LARGER PARTS

Formlabs Castable Wax Resin is suitable for printing and casting larger jewelry and other cast parts. Convert your design to a thin-walled shell to minimize the expansion forces on the investment during burnout. [Parts thicker than 4 mm should be shelled](#), and [drain holes must be added](#) to allow resin to flush out of the hollow interior. Uncured resin will not burn out cleanly, resulting in ash residue defects.

Formlabs recommends [0.7 mm thick walls for hollow shells](#) printed in Castable Wax Resin. A lattice structure can also be added to the interior to improve the handling strength of large shelled parts.

[Learn about the basics of digital jewelry design](#) for best results in both 3D printing and direct investment casting in our white paper.



## 2. Print and Prepare Parts for Casting

Jewelry patterns can be printed in large batches on the Form 2 desktop 3D printer. Packing the build platform with parts offers the best possible efficiency and throughput. After printing in your desired orientation, follow these steps to prepare the patterns for spruing and investing.



### WASHING

Thoroughly washing parts in 90%+ isopropyl alcohol (IPA) is critical to a clean casting. Excess uncured resin can interfere with investment curing and will cause casting defects such as pitting.

Allow the parts to fully dry after removing them from the IPA bath. Use compressed air to ensure all IPA is fully evaporated prior to post-curing and casting. If Castable Wax parts are still sticky after washing and drying, you may need to replace your IPA.

Castable Wax Resin		Castable Resin	
Form Wash	10 min	Form Wash	10 min
Cleaning Kit	10 min + 5 min (second wash in clean IPA)	Cleaning Kit	10 min + 5 min (second wash in clean IPA)

### Note:

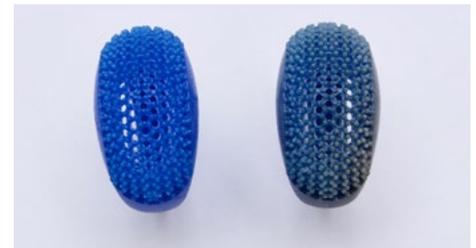
Do not leave parts in IPA longer than necessary. Form Wash lifts parts out of IPA automatically to avoid accidental overwashing and distortion.

### CURING

The polymer structure of a resin pattern should be thoroughly crosslinked by 405 nm light to facilitate a clean burnout. Formlabs resins are cured to different degrees by the Form 2 printer, and some require a post-cure step if they are to be investment cast.

Castable Wax Resin does not require a post-curing step and offers improved casting efficiency. Post-curing Castable Wax parts may cause a small (<1%) degree of shrinkage.

Post-cure parts printed in Castable Resin until the surface is hard and rigid. Rotating parts ensures an even post-cure. [Form Cure](#) will automatically rotate parts, but if using another method, it may be necessary to manually flip or rotate parts during the post-cure. Castable prints will change from bright blue to dark, matte blue during post-cure.



Castable Resin, green (left) and post-cured (right)

Castable Wax Resin		Castable Resin	
Form Cure	Not Required	Form Cure	4 hours @ 60 °C
Nail Salon		Nail Salon	8 hours

### 3. Build the Sprue Tree

Attach the post-processed prints to a main wax sprue with sticky sprue wax. Melt the wax to create smooth junctions between each printed pattern and its feed sprue.



A [wax heat pen](#) makes it easier to join resin patterns to the wax sprue tree.

**Tip:**

Printed resin patterns do not melt. If you have difficulty joining a print to a wax sprue, try using a small amount of super glue or fast setting epoxy.

Arrange thicker parts at the bottom and thinner parts at the top of the tree. 3D printed parts may require slightly more space between parts than a traditional wax tree. If you are casting large “thin-shelled” parts, make sure to fill any drain holes with wax to prevent any investment material from entering the print.

#### SURFACTANT COATINGS

A very common casting defect is caused by bubbles trapped around the pattern while pouring the investment mold. Inexpensive surfactant coatings or “debubblers” such as [Wax Wash](#) help prevent bubbles from sticking to prints. A surfactant coating is especially useful when casting filigree models which are prone to trapping bubbles.

Formlabs recommends dipping your pattern tree into a debubbler solution and allowing it to fully dry before pouring your investment.



## 4. Prepare the Mold

The following steps are a standard procedure for preparing any investment flask mold. A vacuum investing machine helps to evenly mix, degas, and pour the investment easily and cleanly. However, it is also possible to use a separate mixer and vacuum chamber.



- 1 Attach a casting flask to the sprue base. If the flask is perforated, wrap it with clear packing tape to contain the investment.



- 2 Mix investment powder and cold distilled water according to manufacturer's instructions. Adding slightly less water to the mixture will usually increase investment strength, although viscosity will also increase (more difficult to degas). Mix on slow speed until the powder is completely wet.



- 3 Slowly pour the investment down the side of the flask, avoiding the pattern tree. A smooth pour is less likely to trap bubbles. Use a vacuum chamber to extract any bubbles from the flask. Allow the investment to harden and dry.



- 4 Carefully remove rubber sprue base from the flask and allow it to set in a vibration-free environment for 2-6 hours.

Follow the investment manufacturer's safety recommendations. We recommend wearing a dust mask or respirator.

### INVESTMENT MATERIAL OPTIONS

Formlabs recommends using an investment powder advertised to work with resin patterns, such as [Plasticast with BANDUST](#) by Ransom and Randolph. If you are casting thicker parts, consider upgrading to a stronger investment material such as [Ultravest Maxx with BANDUST](#).

Formlabs customers have reported success with Kerr SatinCast and Omega+ by Goldstar Powders. Bonded investments designed for dental applications can also be used, and offer much faster burnout cycles at a higher cost.

When using alternative investments, incorporate the manufacturer's burnout recommendations.

**Note:** The working time for mixing the investment and preparing the mold varies depending on flask size. Follow the investment manufacturer's instructions for mixing ratios and bench set time.

## 5. Burnout and Casting

Place the casting flask in the burnout oven and heat using the recommended [Burnout Schedule](#). Make adjustments depending on the investment instructions, flask size, and amount of printed material.

If starting the burnout with a hot oven, make sure that the flasks have been resting for at least 5 hours, otherwise the plaster might crack when the water expands and turns into steam.

Formlabs recommends using a well-ventilated furnace (with an inlet and an outlet), to provide sufficient air flow throughout the chamber and to safely exhaust all vaporized resin material.

### SHORT BURNOUT

Castable Wax Resin is 20% wax-filled, which allows printed patterns to partially break down earlier in the burnout cycle — enabling faster burnout times for Castable Wax patterns.

Short burnout is limited to certain geometries and higher end investment materials such as [R&R's Ultravest Maxx](#). Learn the details in the [Usage Guide for Castable Wax](#).

#### Tips:

- Venting is essential, but it can cause the temperature in the oven to drop. Monitor the oven and flask temperature and adjust your process as you develop a burnout schedule suited to your own equipment.
- If using active ventilation, increase suction as much as possible to improve airflow throughout the oven.
- If the oven is full, burnout will be less effective per flask. Attach an oxygen generator to the oven to increase the airflow.

### CASTING

Remove the mold from the furnace and cast metal. Centrifugal or vacuum casting machines such as the Neutec J2R (USA) and the Indutherm MC-series (EU) are simple to use and highly controllable.

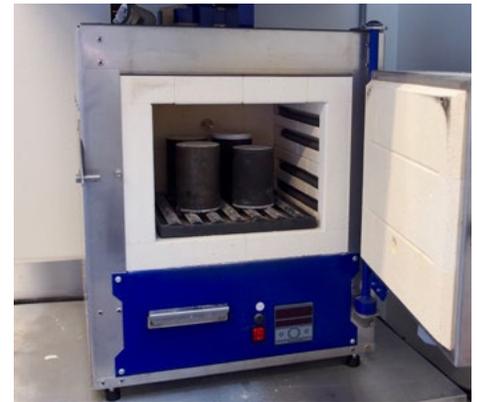
After casting, carefully quench the mold in water and wash away the investment.

### PRECIOUS METAL COMPATIBILITY

Formlabs has tested gold, silver, and bronze castings from Castable Wax patterns.

Metal compatibility is foremost a property of the investment. Different metals require varying degrees of temperature resistance from the investment.

Castable Wax requires temperatures of at least 732 °C to complete burnout. Ask the manufacturer if you are unsure about resin pattern compatibility with a specific investment.



*Place flasks in a well ventilated burnout oven.*



*Vacuum or centrifugal casting methods improve fill to thin details.*



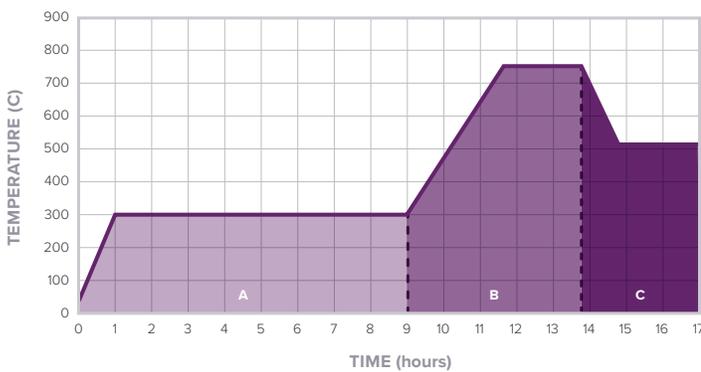
*Quench and devest the flask by submerging it in water.*

# Burnout Schedule

Formlabs offers Castable Wax and Castable Resins for jewelry investment casting. Castable Wax Resin is designed to offer improved flexibility in its burnout schedule, and casters should first and foremost follow the manufacturers instructions for their investment material when using Castable Wax. Castable Resin is a legacy product which requires a more specific, gentle burnout schedule.

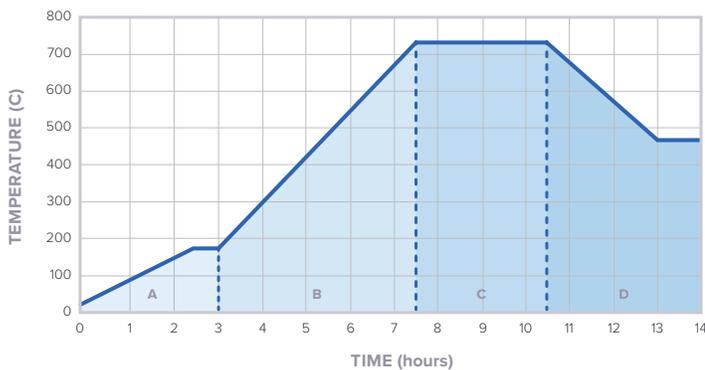
Recommended schedules for each material are shown below, for use with [R&R Plasticast with BANDUST](#) investment.

## Castable Wax Resin



	PHASE	TIME	SCHEDULE °C	SCHEDULE °F
A	Insert Flasks	0 min	21 °C	70 °F
	Ramp	60 min	4.7 °C / min	8.4 °F / min
	Hold	480 min	300 °C	572 °F
B	Ramp	100 min	4.5 °C / min	8.1 °F / min
	Hold	180 min	750 °C	1382 °F
C	Ramp	60 min	- 4.0 °C / min	- 7.1 °F / min
	Casting Window	Up to 2 hours	512 °C (or desired casting temp)	954 °F (or desired casting temp)

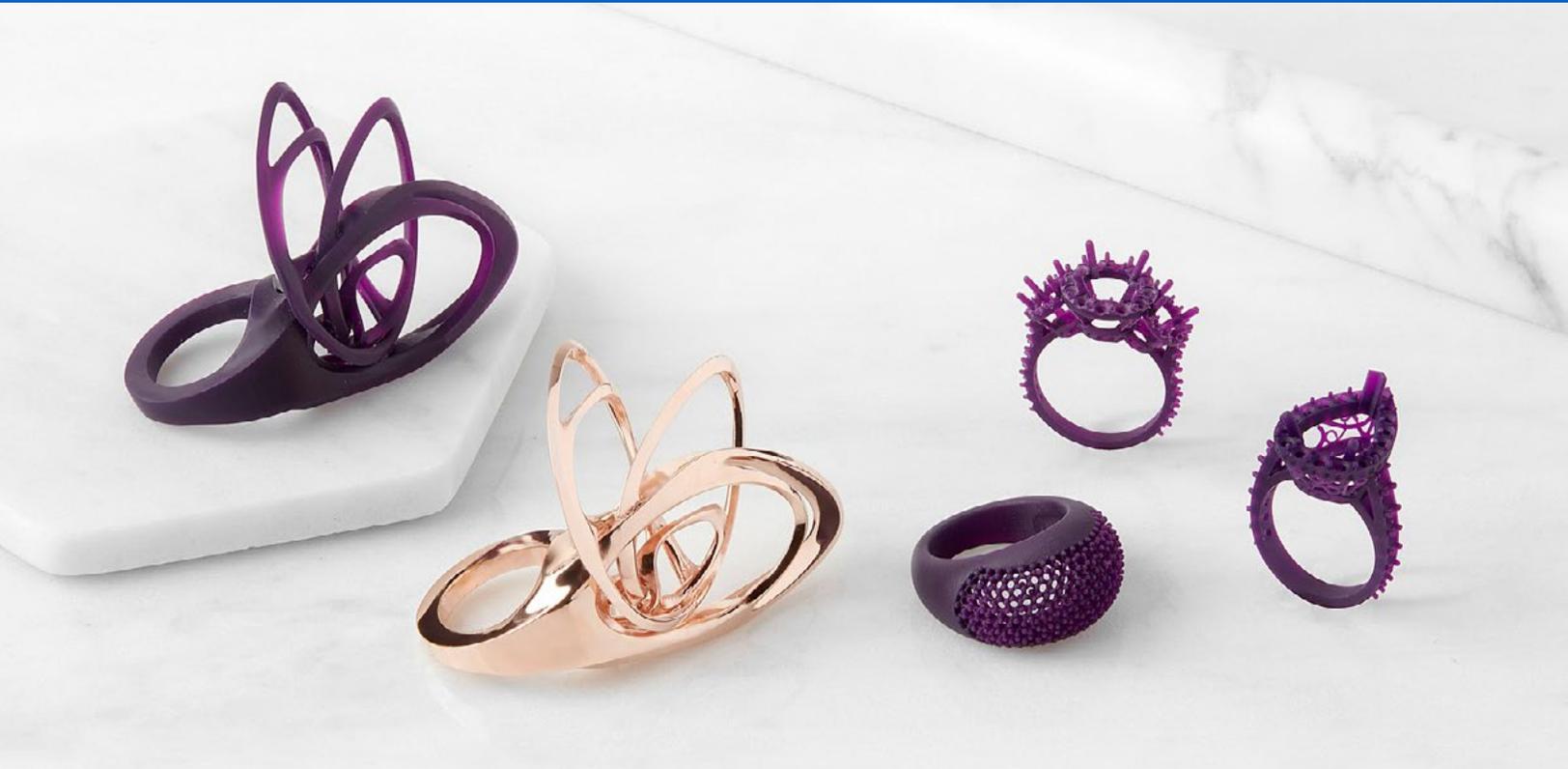
## Castable Resin



	PHASE	TIME	SCHEDULE °C	SCHEDULE °F
A	Insert Flasks	0 min	Room temp	Room temp
	Ramp	150 min	1.0 °C / min	1.9 °F / min
	Hold	30 min	177 °C	350 °F
B	Ramp	270 min	2.1 °C / min	3.7 °F / min
C	Hold	180 min	732 °C	1350 °F
D	Ramp	150 min	- 1.7 °C / min	- 3.0 °F / min
	Hold (casting window)	Up to 2 hours	482 °C or desired casting temp	900 °F or desired casting temp

# Troubleshooting Checklist

PROBLEM	CAUSE	SOLUTION
<b>Small bubbles on casting</b>	Investment is too viscous	Increase amount of water added to investment.
	Investment working time too short to fully degas flask	Use cold water in mixture.
	Bubbles trapped against pattern	Use a surfactant coating (debubbler).
<b>Metal flashing</b>  <i>or</i> <b>Jagged blobs on casting</b>	Investment too weak and cracked or damaged during burnout	Decrease amount of water added to investment.
		Increase bench set time after investing.
		Increase spacing between resin patterns.
		Slow burnout ramp rate.
<b>Porous surface on casting</b>	Metal shrinking during cooling, without a reserve of molten metal to draw from	Add reservoirs to sprue tree.
<b>Partial fill on thin sections or filigree</b>	Metal freezing in mold	Place additional sprues.
		Increase casting temperature.
<b>Pitted surface</b>	Ash residue remaining from incomplete burnout	Extend time at peak burnout temperature.
		Increase air flow in burnout oven.
		Evacuate flask with air prior to casting.



*Papilio Ring, LACE by Jenny Wu*

## Learn More About Digital Jewelry Fabrication

To learn more about Formlabs printers and Castable Wax Resin, speak with our team:

<https://formlabs.com/company/contact/>

Casting is an involved process, so for best results, we suggest working with a casting specialist. To find our list of recommended casting houses, visit:

<https://formlabs.com/company/recommended-casting-houses>

Special thanks to **Lars Sögaard Nielsen** and the **KEA** (Copenhagen School of Design and Technology) for letting Formlabs document their casting process.

### RELATED RESOURCES

#### [Designing for 3D Printed Jewelry](#)

An introduction to desktop stereolithography 3D printing for jewelry, covering tips and tricks for success in printing and casting with many detailed examples.

#### [Vulcanized Rubber Molding for 3D Printed Masters](#)

Learn how to use the Form 2 to produce multiple wax pieces by 3D printing a mold master for use in room temperature and medium temperature vulcanization processes.

#### [Selling Custom Jewelry with 3D Printing](#)

The Form 2 is easy to use and is suitable for operation in a showroom or retail environment. Learn strategies for using 3D printed maquettes to provide a better client experience for custom work.