



FORMLABS APPLICATION GUIDE:

Recommended Burnout Process and Casting Guide

Use Formlabs Castable Resin to produce detailed fine jewelry through the investment casting process. Developed specifically with investment casting in mind, Castable burns out cleanly with no ash or residue.

[Request a Castable Sample >](#)

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Essentials

Made by Formlabs

- Form 2 (SLA) 3D Printer
- Castable V2 Resin
- PreForm Software (free)
- Finish Kit or Form Wash
- Form Cure

Made by Third Parties

- R&R Plasticast with BANDUST investment
- Furnace, vacuum investment machine, and casting system such as Indutherm MC-series
- Alternative curing solutions: NextDent LC Curing Lightbox or Gesswein UV Curing Chamber



Introduction

Castable Resin is an acrylate photopolymer. To successfully cast resins, it helps to acknowledge some differences from casting traditional wax pieces.

1. Thermal Properties - Castable Resin does not melt at low temperatures, but transitions to a gas, which requires a different process to a traditional wax schedule. Allowing the material to transition into a gas bit-by-bit reduces the chances of the investment cracking due to rapid expansion of the printed part. Use a slow and steady ramp to the maximum temperature, and extend the hold for thicker geometries and bigger flasks. Due to this gas transition, any efforts to improve airflow, including additional venting, active ventilation, or blowing out molds when possible, are advantageous. Ideally, the thermal expansion of the investment should be well suited to the thermal expansion of your 3D printed material. We specifically recommend Plasticast with BANDUST, however any investments recommended for photopolymers — including some dental investments—are good starting points.

2. Chemistry - When the Form 2 stereolithography (SLA) 3D printer cures Castable Resin, it causes liquid polymer chains to cross-link, building a solid layer. Additional curing by applying 405 nm light—the same wavelength as the Form 2's laser — and heat, once the print is finished, continues this process. A highly cross-linked part will be slightly harder to break down than a soft part, but this additional strength makes parts easier to handle and can increase their integrity in the investment. Cure time is highly dependent on your equipment and should be extended for thicker parts.

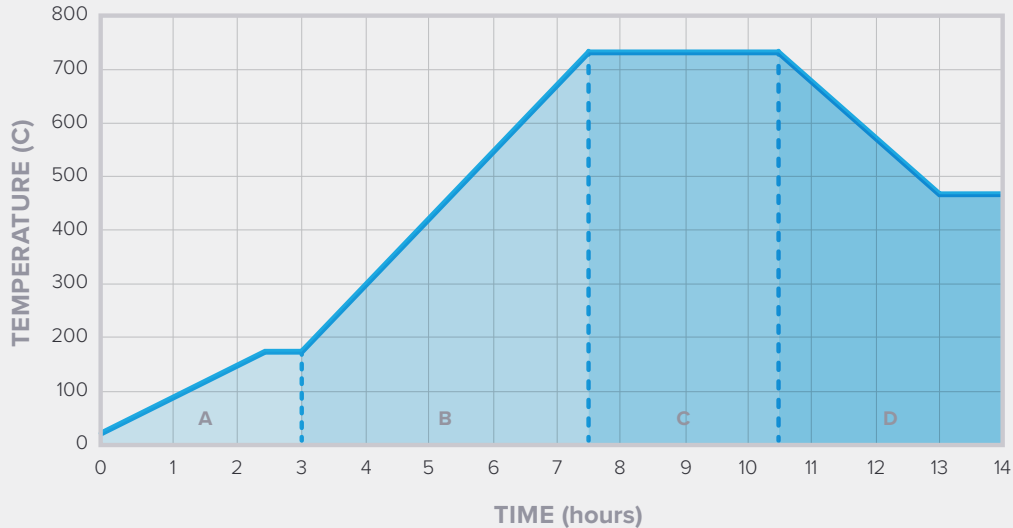
While Castable Resin is optimized for the best burnout performance, casting depends on a number of variables from part design of the piece to the specific equipment being used.

In this guide, we provide guidelines and recommendations that have proven successful during our testing process to help you develop a specific burnout and casting process.

Note: While not covered in this guide, some customers report success casting Formlabs Clear Resin. More advanced casting houses familiar with successfully casting photopolymers may want to try this material, which offers high detail, good surface finish, and a faster cure cycle.

Burnout Schedule: Celsius

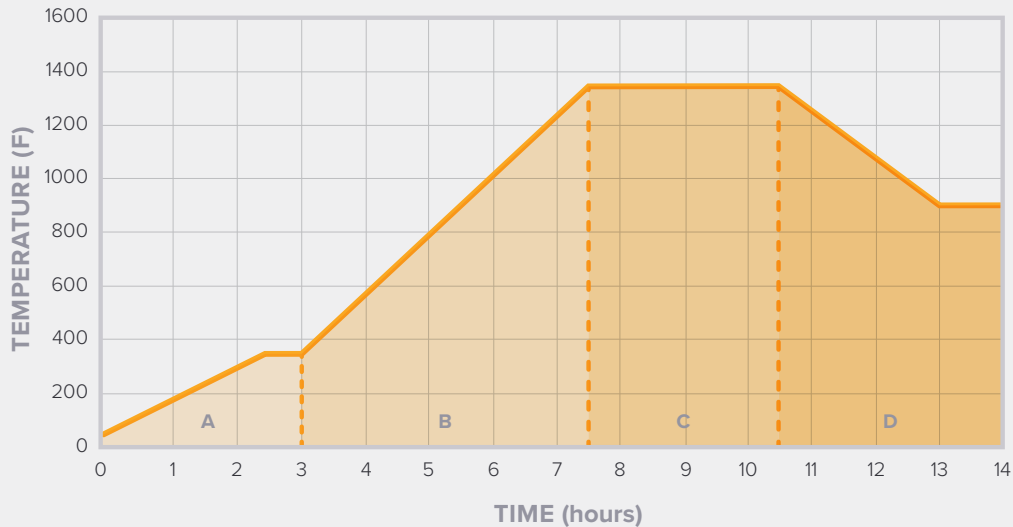
The burnout schedule consists of four phases. Various factors, such as part thickness, total resin volume, flask size, investment type, and final casting temperature affect the ideal burnout schedule. Use this burnout schedule as a starting point and make adjustments as needed.



DESCRIPTION		PHASE	TIME ELAPSED	SCHEDULE °C
A	Insert flasks into a cold oven.	Insert Flasks	0 min	20 °C (room temp)
	Warm Up Castable Resin starts to burn out transitioning directly from a solid to a gas. The slow ramp rate and added hold allow the transition to happen slowly, reducing the chance of cracking in the investment.	Ramp	0 min	for 150 min (~1.0 °C / min)
		Hold	150 min	177 °C for 30 min
B	Main Ramp Castable Resin continues to burn out. The duration of this ramp should be adjusted depending on the size and number of flasks, and the thickness and total volume of Castable material being burned out.	Ramp	180 min	for 270 min (~2.1 °C / min)
C	Main Hold Castable Resin should completely burn out during this hold. The duration of this hold depends on the size and number of flasks, and the thickness and total volume of Castable material being burned out. Thicker parts require a longer hold. Increased airflow inside the oven may allow for a shorter hold.	Hold	450 min	732 °C for 180 min
D	Cool Down The last ramp takes the flask down to your desired casting temperature. The hold allows the center of the flask to reach this lower temperature. Adjust this hold relative to the size and number of flasks	Ramp	630 min	for 150 min (~1.7 °C / min)
		Hold	780 min	482 °C (or desired casting temperature) for 60 min
	Remove flasks at your desired casting temperature.	Remove Flasks	840 min	482 °C

Burnout Schedule: Fahrenheit

The burnout schedule consists of four phases. Various factors, such as part thickness, total resin volume, flask size, investment type, and final casting temperature affect the ideal burnout schedule. Use this burnout schedule as a starting point and make adjustments as needed.



DESCRIPTION		PHASE	TIME ELAPSED	SCHEDULE °F
A	Insert flasks into a cold oven.	Insert Flasks	0 min	68 °F (room temp)
	Warm Up Castable Resin starts to burn out transitioning directly from a solid to a gas. The slow ramp rate and added hold allow the transition to happen slowly, reducing the chance of cracking in the investment.	Ramp	0 min	for 150 min (~1.9 °F / min)
		Hold	150 min	350 °F for 30 min
B	Main Ramp Castable Resin continues to burn out. The duration of this ramp should be adjusted depending on the size and number of flasks, and the thickness and total volume of Castable material being burned out.	Ramp	180 min	for 270 min (~3.7 °F / min)
C	Main Hold Castable Resin should completely burn out during this hold. The duration of this hold depends on the size and number of flasks, and the thickness and total volume of Castable material being burned out. Thicker parts require a longer hold. Increased airflow inside the oven may allow for a shorter hold.	Hold	450 min	1350 °F for 180 min
D	Cool Down The last ramp takes the flask down to your desired casting temperature. The hold allows the center of the flask to reach this lower temperature. Adjust this hold relative to the size and number of flasks	Ramp	630 min	for 150 min (~-1.8 °F / min)
		Hold	780 min	900 °F (or desired casting temperature) for 60 min
	Remove flasks at your desired casting temperature.	Remove Flasks	840 min	900 °F

Recommended Investment

We specifically recommend [Plasticast with BANDUST](#). If seeking alternatives, look for investments advertised to work with photopolymers. Customers have reported success with Kerr SatinCast and Omega+ by Goldstar Powders. You can also experiment with bonded investments, like those typically used for dental applications. Some casting houses have also developed proprietary investments.

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

[R&R Plasticast with BANDUST - Find a dealer](#)

Technical Data for Formlabs Castable V2

	METRIC	IMPERIAL	METHOD
Mechanical Properties¹			
Tensile Strength at Break	11.6 MPa	1680 psi	ASTM D 638-10
Young's Modulus	220 MPa	32 ksi	ASTM D 638-10
Elongation at Failure	13%	13%	ASTM D 638-10

NOTES:

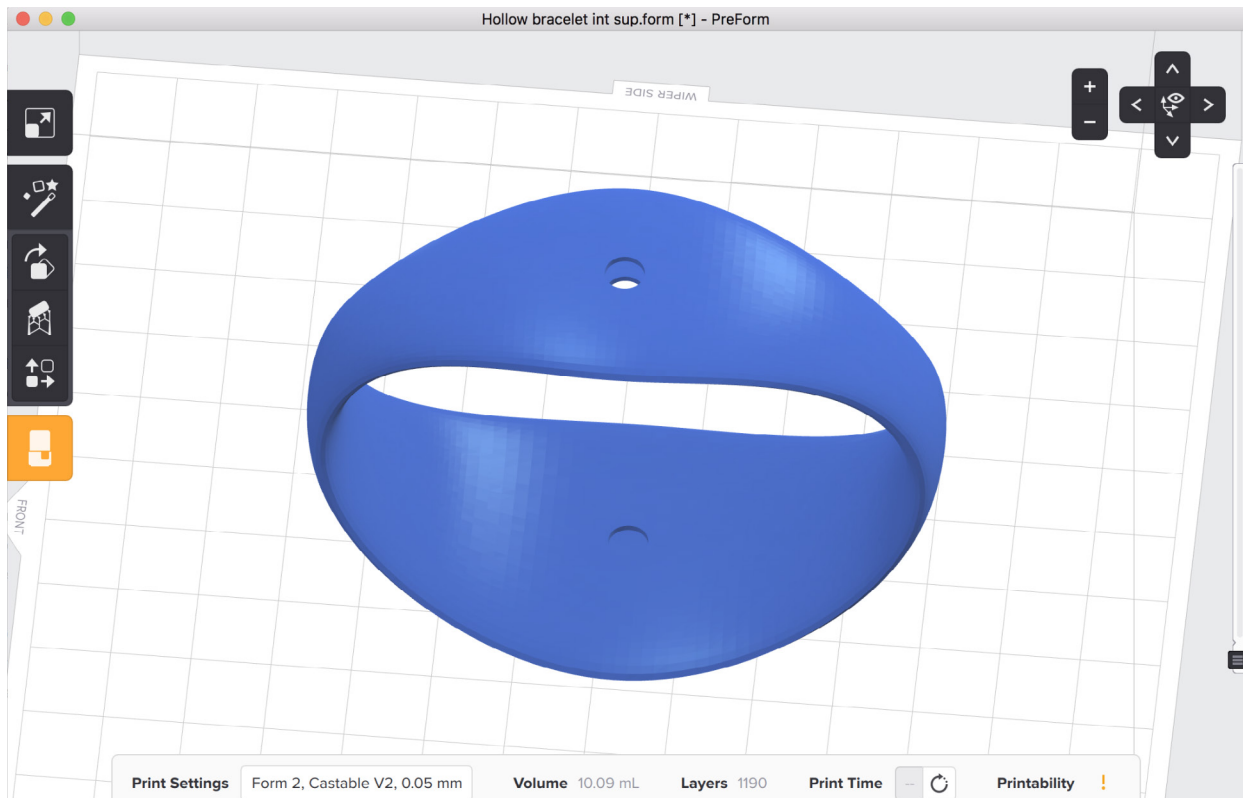
¹Data was obtained from parts printed using Form 2, Castable 50 µm Fine Detail settings and post-cured with 2.5 mW/cm² of fluorescent bulb UV light, centered at 405 nm.

1. Design for Casting

Casting is both a skill and an art form. For successful results, the design of the piece to be cast is as important as the material properties.

TIPS:

- Design for material flow when modeling. Avoid sharp corners and reduce transitions between thick and thin profiles on the same piece.
- Instead of adding wax sprues post-print, build them into the part directly using CAD design software. For 3D printed sprues, design the sprue diameter no larger than the cross-sectional wall thickness of the part.
- Design thicker models to be hollow in CAD (possible through a program like [Meshmixer](#)) with respect to guidelines in [Formlabs' Design Specs](#). This allows the part to collapse inward instead of only expanding outwards against the investment. For more elaborate or larger hollow pieces, internal struts may be used. Design airflow vents to allow for sufficient ventilation during burnout (see image below).

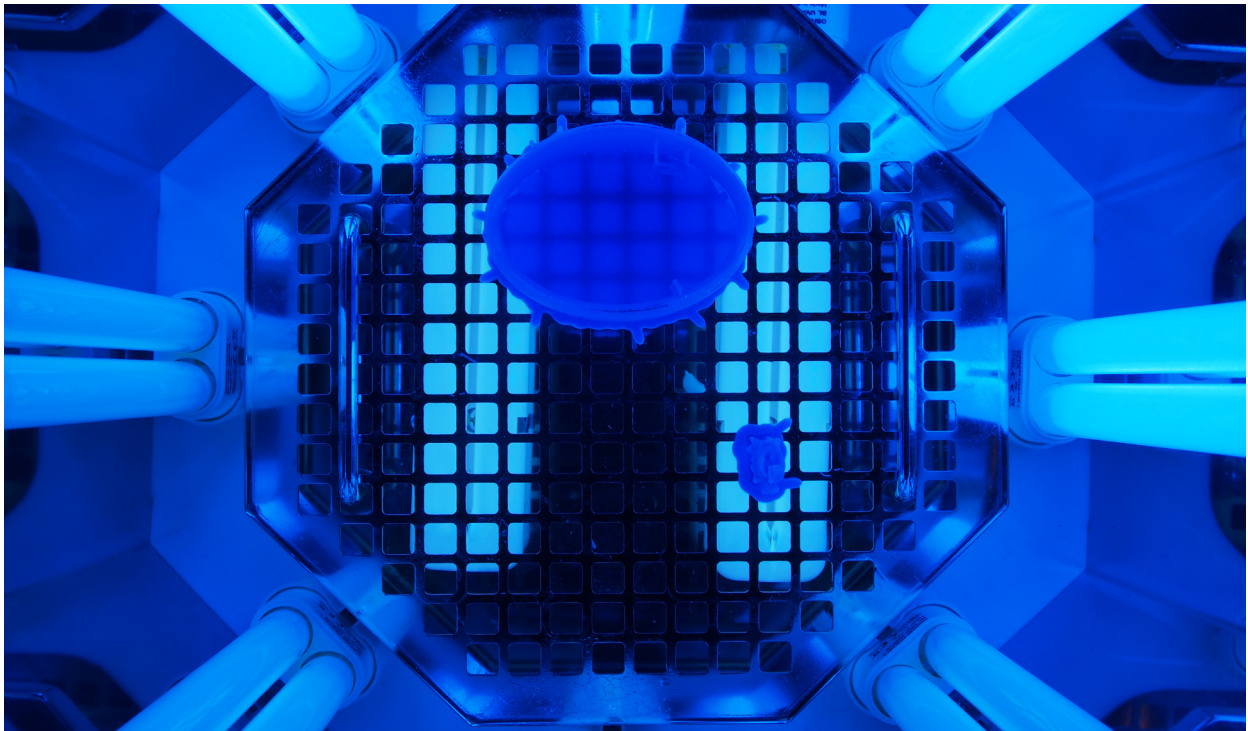


[Learn about the basics of digitally designing jewelry](#) for best results in both printing and casting in our white paper.

2. Print and Prepare Parts for Casting

Print parts with [optimal orientation and support](#) and follow the [standard post-print procedure](#). For extra care, we recommend two short sequential five-minute rinses in clean 90%+ isopropyl alcohol. Do not leave parts in IPA longer than necessary.

Allow the parts to fully dry after removing them from the IPA bath. Make sure the IPA is fully evaporated prior to post-curing and casting as it could interfere with the investment and cause pitting.



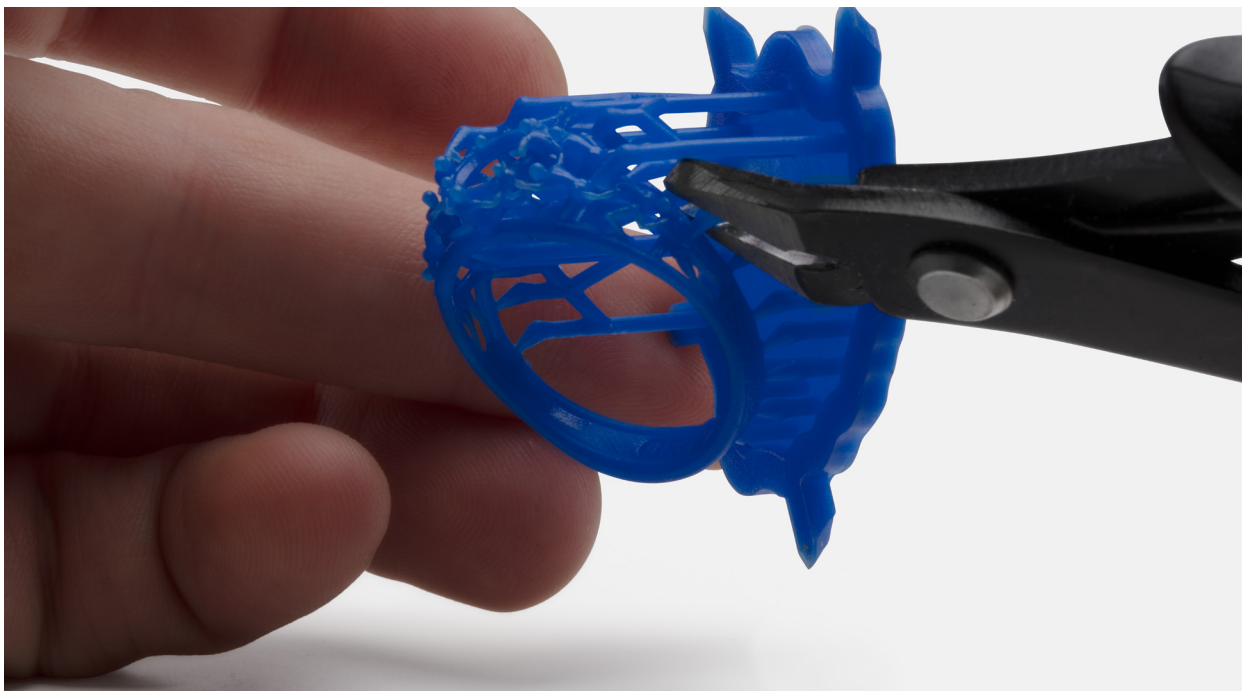
Post-cure the parts under 405 nm light and heat until the surface is hard and rigid. Rotating parts ensures an even post-cure. [Form Cure](#) will automatically rotate parts, but if using another method, it may be necessary to manually flip or rotate parts during the post-cure.

To maximize part strength and increase the parts' integrity in the investment, prints made with Castable Resin should be fully post-cured. Post-curing solutions vary widely in terms of heating capability, light wavelength, and output. When using Form Cure, we recommend post-curing parts at 60 °C for at least four hours. Small UV sources like home UV nail dryers use UV light (0-400 nm) and may take up to eight hours to properly post-cure parts, while industrial UV curing ovens may take only two hours.

Note: UV nail salons prove an effective entry level solution, partly because the parts are typically placed very close to the bulbs. The parts get very hot (sometimes greater than 60 °C) and the heat helps the parts fully cure. Higher cure temperatures provide a faster cure, but make sure to inspect parts for warping.



During post-curing, part color might change from bright blue to dark, matte blue.



If necessary, carefully remove support material from your print. Using fine sandpaper (400 grit and above), gently sand away support marks.

It is important for all surfaces under the supports to be cured evenly. For larger parts like bracelets, it can be beneficial to cure on supports to counteract any possible warping and help the part retain its original shape at higher temperatures. Remove supports after curing. If there are still soft, bright blue parts on the surface that are uncured, perform an additional cure cycle. Curing parts longer is always preferable to having semi-cured parts. Extend your post-cure time as your process allows.



Polish the surface using polishing paper or a rotary tool with a buffing attachment. Do not finish the print with mineral oil after sanding.



Add wax sprues and gates to the print, similar to lost-wax casting. Ideal positioning varies with part geometry.

TIPS:

- If using wax sprues, create the thickest sprues possible and place them on the thickest part of the model (if it doesn't interfere with the design).
- Make the path of airflow inside the cast as short as possible. Smaller trees with less resin burn out more easily.
- Place thicker parts at the bottom and thinner parts at the top of the tree.
- Space 3D printed pieces further apart on the tree than typical for a tree of wax pieces. More investment in the gaps between parts helps resist any thermal expansion.
- If possible, thicker parts should be hollowed out (see Design for Casting). Add ventilation holes within the design to ensure sufficient airflow during burnout. Close these holes with wax before adding sprues to avoid the investment getting inside the model.



3. Prepare the Mold



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

We recommend using Plasticast with BANDUST investment for every cast, as it has proven to work best with Formlabs' Castable Resin. Plasticast is also compatible with mixed trees that include wax and resin parts and can be used within the same burnout cycle.



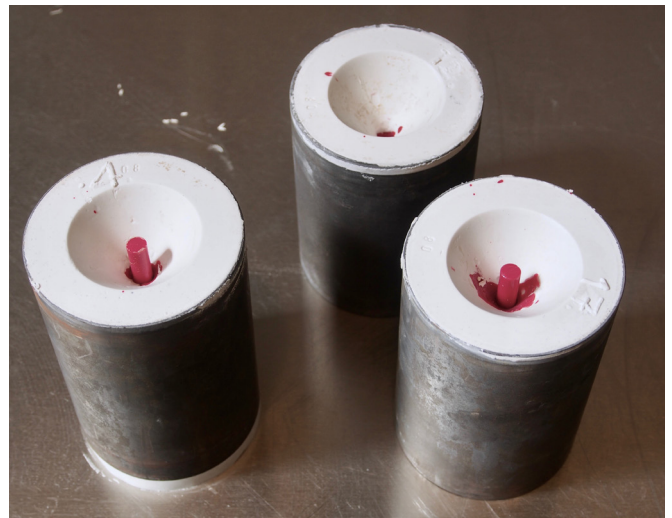
Weigh and mix the investment, and pour it into the casting flask according to the manufacturer's instructions. For example, instructions for R&R's Plasticast with BANDUST.

Note: The workflow for mixing the investment and preparing the mold varies depending on flask size. Make sure to follow the investment manufacturer's instructions and adjust the burnout schedule as needed.

TIPS:

- Mix on slow speed until the powder is completely wet.
- Slowly pour the investment down the side of the flask to avoid damaging the fragile wax tree.
- Degas according to the manufacturer's instructions. You can release the vacuum slightly, but you'll need maximum vacuum to avoid air bubbles in the cast.
- Carefully remove rubber sprue base from the flask and allow it to set in a vibration-free environment for 2-6 hours.

Note: Follow the investment manufacturer's safety recommendations. We recommend wearing a dust respirator while preparing investment.



4. Burnout



Place the casting flask in a cold furnace and heat using the burnout schedule as a guide. Make adjustments depending on the investment instructions, flask size, and 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.

We recommend using a well-ventilated furnace with two ventilation points, one at the top and other at bottom of the oven, to provide sufficient airflow throughout the chamber for the resin vapor to be carried out the exhaust.

TIPS:

- While venting is helpful, it can cause the temperature in the oven to drop. As much as possible, be sure to monitor the oven and flask temperature and adjust your process as you develop a burnout schedule suited to your own equipment.
- If there is suction on top of the oven, turn it up as high as possible to create higher airflow throughout the oven.
- If the oven is full of flasks, the airflow is less effective per flask. Attach an oxygen generator to the oven to increase the airflow.



Remove the mold from the furnace and cast metal. Centrifugal or vacuum casting processes can be helpful in quickly filling the mold.

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





Remove the parts from the casting tree and finish them following your regular routine.



Troubleshooting Checklist

Design Considerations

1. Design parts for successful 3D printing. When preparing prints in PreForm, check for the proper orientation and support creation.
2. For complex and highly detailed pieces, consider designing custom supports in your CAD program. Fine supports can be used on individual prongs or fanned out along the inside of a ring with detail all the way around its surface.
3. Adopt good habits in designing parts for a successful burnout. Consider the material flow in the piece and also design for the negative space to easily fill with investment.
4. For an easier burnout of thick pieces, consider hollowing out the part and printing a thin-walled shell.
5. Avoid transitions from thick to thin sections in the part and in printed sprues. Try to match printed sprue diameter to the cross section of the part wall it is attached to.

Printing and Preparing 3D Prints

6. Instead of one long soak, wash parts multiple times for short periods in very clean and highly concentrated isopropyl alcohol. Do not leave parts in IPA longer than necessary.
7. Ensure printed parts are fully dry, and all IPA has evaporated prior to post-curing.
8. Cure parts for at least 4 hours at 60°C in Form Cure. Extend cure time until parts feel adequately rigid, particularly for larger and thicker pieces. 80 °C may be used for a faster cure, but be wary of possible warping on fine or delicate parts.

Sprueing

9. If using wax sprues, make them as large as possible.
10. Whether wax or printed, place sprues for the shortest exit path of material.

Investment

11. Use an investment suited to casting photopolymers.
12. Prepare investment according to manufacturer's instructions.

Burnout

13. Use Formlabs' recommended burnout schedule as the starting point.
14. Adjust the burnout schedule according to investment manufacturer instructions.
15. Adjust the ramp rate and hold times dependent on part geometry, total volume, and flask size.
16. Adjust final hold temperature dependent on metal casting temperature.
17. Maximize the airflow and ventilation during burnout.
18. Adjust the burnout schedule for temperature fluctuations as a result of increasing airflow.
19. Calibrate your oven regularly to allow for the most accurate display of cycle times and temperatures.



Learn More

To learn more about Formlabs printers and Castable 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 CONTENT

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A great introduction to desktop SLA 3D printing for jewelry, covering tips and tricks for both success in printing and casting with many detailed examples.

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

The Form 2 can also be used 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](#)

Customers love the Form 2 for both its ease of use and suitability for operation in a showroom or retail environment. Learn strategies for using 3D printed maquettes to provide a better client experience for custom work.