

D0062 - Gen 2 Optical Phantom Recipe

Rev2

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Critical Materials

Openwater PN	Description	Manufacturer	Mfg. PN
1000-0121	CARBON BLACK, ACETYLENE, 100% COMPRESSED, 99.9+%, THERMO SCIENTIFIC	THERMO SCIENTIFIC CHEMICALS	04552730 Fisher Catalog #AA4552730
1000-0122	TITANIUM (IV) OXIDE, ANATASE, POWDER, ~325 MESH, >99% TRACE METALS BASIS	SIGMA-ALDRICH	248576
1000-0129	CLEAR URETHANE CASTING RESIN	SMOOTH-ON	CRYSTAL CLEAR 200

Module Phantom Mold Process

Materials

- 3D printed phantom positive
 - Helps to have threaded hole on bottom to help get out of mold
- Smooth-On Mold Star 30. For 3000-0617, use the following quantities -

- 390 g Mold Star 30 Part A
- 375 g Mold Star 30 Part B
- (By weight = 100A:96B, By volume = 100A:100B)
- Smooth-On Universal Mold Release
- Custom acrylic container for mold
- 1 liter disposable mixing containers
- Acrylic/glass stir sticks
- Kitchen scale
- Super glue

Setup

- Preheat oven if intend to heat cure the mold method, see caveats below

Methods

1. Use 1-2 small dots of superglue to attach positive to bottom of acrylic container
2. Spray inside lightly with Smooth-On Universal Mold Release, single light coating should be enough, any more can cause cure inhibition
3. Mix silicone vigorously for 4-5 minutes, being sure to scrape sides and bottom vigorously to avoid unmixed parts on the sides (leading to curing inhibition)
4. Degas in vacuum for 2-3 minutes to remove any air bubbles, just make sure to use large enough container (at least 3x larger and watching closely for overflow)
5. Cast (pot life is 45 minutes) and let sit at least 6 hours
 - a. If you are using a 100% solid or sealed negative can, can put into oven at 60 C to reduce cure time down to half hour or so
 - b. Do not use this method with a standard 3D printed positive, as the air inside will expand and warp the mold
6. Carefully break acrylic container apart to get the mold out
7. Insert bolt into threaded hole of the positive to help get it out, work the mold by flexing and stretching sides to try and break all surfaces before fully demolding

Results

- Mold should be quite uniform and not sticky if done correctly

Module Polyurethane Phantom Casting Process

Materials:

- Smooth-On Crystal Clear 200. For 3000-0617, use the following quantities -
 - 261.6 g Crystal Clear 200 Part A
 - 235.5 g Crystal Clear 200 Part B

- (Mix ratio by weight = 100A:90B (density is 1.036 g/mL))
- 0.507 g of scatterer absorber mix. (Equiv. 1.0 g/L TiO₂ and 0.056 g/L carbon black.)
 - If not already made, create a large amount of the scatterer/absorber mix to ensure better accuracy.
- 1 liter disposable mixing container
- Glass stirring rods
 - Do not use sharp edged acrylic/plastic stirring rods as they can scrape plastic off the container into the polyurethane mix
- Kitchen scale
- High precision scale (Torbal AD120)

Setup:

- Ensure relative humidity is less than 50%, if not, run space heater and/or air conditioner on dehumidify mode with door closed until no more than 50% is reached
- Preheat the entire silicone mold in the gray Quincy Labs Model 10 Lab Oven at 100 C for at least one hour; use oven at ~4.5 setting and confirm with alcohol thermometer on top
 - Heating up to 60 C instead of 100 C will lead to suck in around the corners and more bubbles that get stuck on edges/corners/top

Methods:

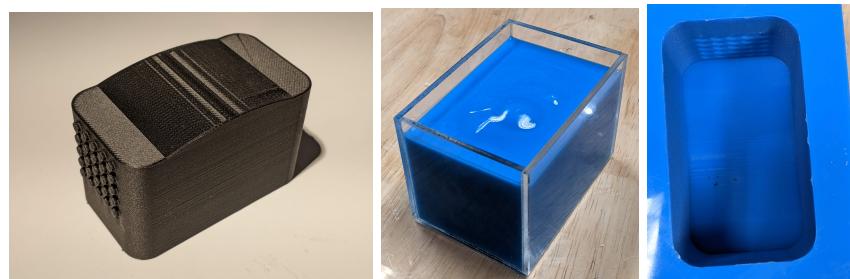
1. Coat all features and inside of mold with light coating of Smooth-On Universal Mold Release
 - a. Do not use too much as this will cause cure inhibition
2. Mix scatterer/absorber concentrated powder mixture with ~10 mL of part B, trying to grind in as much as possible like a mortar and pestle
 - a. Use the high precision scale (Torbal AD120) when measuring less than 120g
 - b. When mixing, be sure to get all of the powder that has static-stuck to walls of mixing container
3. Add remainder of part B
4. Place mixture in unheated sonication bath for 30 minutes covered with cling film
5. Mix in part A and stir “slowly but thoroughly” for 2 minutes, note that pot life is 9 minutes
6. Degas mixture for no more than 4-5 minutes
 - a. Do not degas the mixture once poured into the mold, the warm mold (and especially the stainless steel rods) will catalyze the curing process on contact
7. Just before closing Part A container, spray Smooth-On XTEND-IT Dry Gas Blanket into it for a few seconds; spray lightly so as to not cause the polyurethane to get splashed back out
8. Pour mixture into mold fresh, out of the oven, at a quick rate but trying to keep laminar flow and avoiding bubbles being generated
9. Cure time is 16 hours at room temperature
10. Silicone mold should come off relatively easily, work the mold by flexing and stretching sides to try and break all surfaces before fully demolding
11. Results:

12. Cast should be quite uniform with no visible white or black specs from the titanium dioxide or carbon black, respectively
13. If sticky/uncured, can be baked off with the lab oven
14. Machine per 3000-0617 drawing and install barbed inserts

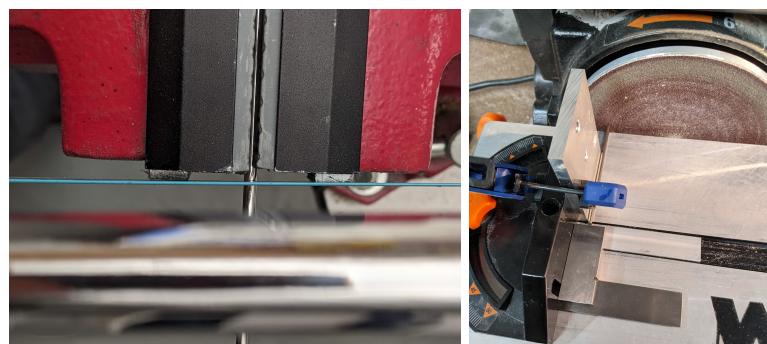
Additional steps for flow phantoms

See 'Flow Phantom Universal X2' model for positive mold

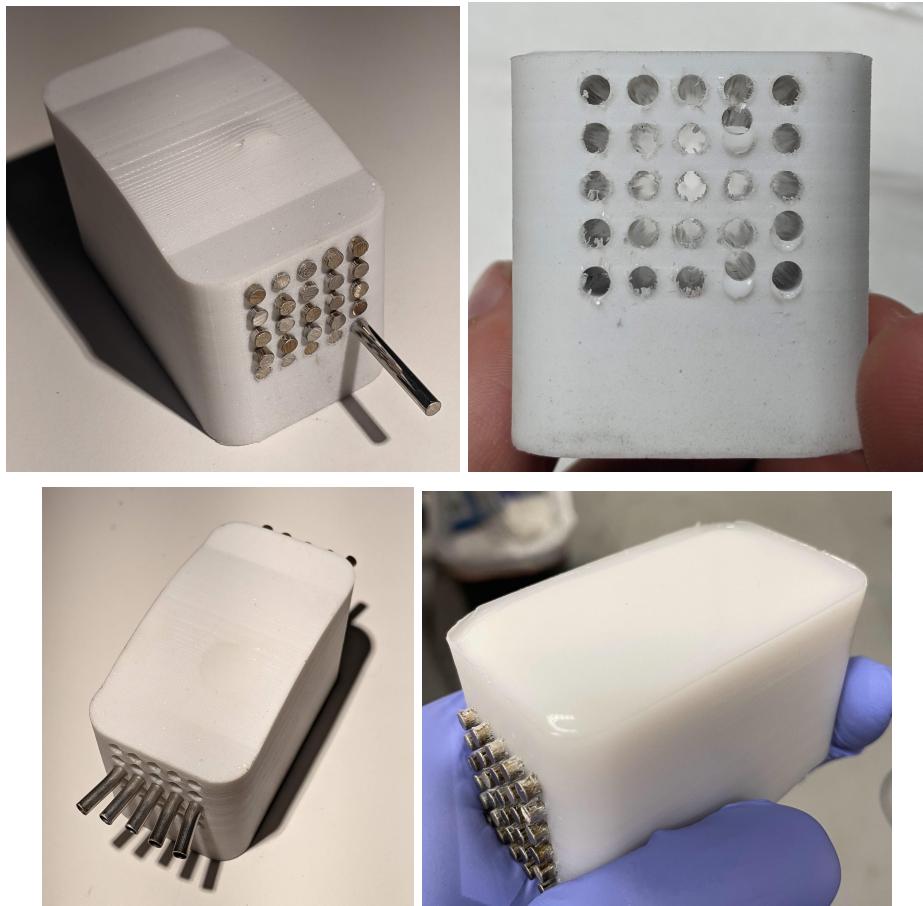
1. Cut stainless steel rod into 25 segments of length 74 mm (+0.0 -0.3) for molding tubular cavities into the phantom
2. Material: $\frac{1}{8}$ " diameter 304 stainless steel rod with polished finish #8 (McMaster Carr)
3. Cut rods to length with diamond tile saw, and sand to final length with 120 grit paper
4. Coat stainless steel rods with mold release, install into silicone mold
5. Spray mold interior with mold release
6. Pre-heat mold to 100C
7. Seal ends with loctite 4311 applied with squeeze bottle



Positive and negative molds



Cutting and finishing stainless steel rods



Flow phantom at various stages of construction