

Acrylic Phantom Frames

- Use 5 total (alternating 3 without baffles, 2 with baffles)
- Use acrylic cement (dichloromethane) to attach 5 frames together
 - Make sure that they are squared up, otherwise they may not fit in tanks
 - Use something underneath frames during this process so that they don't cure to working surface
- Attach wooden cotton-tipped applicators to acrylic frame with UV-curing cement if desired
- Frames are from TAP Plastics, ask Wilson to order more
- Give frames an assembly number per the Built Phantom List and Specs. Ideally label the frame on all three sides and engrave at least one of these. Please touch base with Wilson and/or Brad if you have any questions.

GelWax

- Melt gelwax on medium to high heat, stirring occasionally
 - 200-250 g are needed per phantom
 - There should be two marker dots on heater to shoot for that will keep it warm but not smoking too much
 - Use thermometer to check temperature ideally
 - 190°F (88C) = molasses/honey
 - 235°F (107C) = melted ice cream
 - 280°F (127C) = water
 - Heating to at least 280°F and letting sit for a few minutes without any agitation should adequately degas the gelwax
 - Add in all of the TiO₂ mixture. To be on the safe side, it is preferable to pour a bit of the molten gelwax into the empty mineral oil/TiO₂ cup in order to 'rinse' it out and extract as much of the TiO₂ as possible.
- Mix TiO₂ in mineral oil at ~0.4 g/g (use lower ratio if too difficult to dissolve, ideally you want to use as little mineral oil as possible)
 - Sonicate mixture in bath for at least 10 minutes, stirring occasionally to make sure larger particles on side get mixed in and broken up
 - Gelwax's density at room temperatures is 0.856 g/mL
- Use recently cleaned acrylic or glass under frame to seal bottom
 - Edges don't need to be taped, as the gelwax will cool and solidify rapidly as it tries to fill in any cracks
 - Use a thin layer of mineral oil as release agent on anything you don't want gelwax sticking to
- If using cotton-tipped applicators, you may find it worth it to keep heating the top of the phantom with the heat gun in order to keep the gelwax molten. The cotton-tipped applicators will slowly be impregnated with gelwax and subsequently release lots of small air bubbles into the gelwax; so keeping the gelwax molten will allow more of the air bubbles to rise to the surface and pop. This can take 10-15 minutes or more.

- A better alternative would be to fully impregnate the cotton-tipped applicators while melting the gelwax, and then figure out a way to securely mount them in the frame before pouring all the gelwax in.
- Be sure to let the entire frame cool to room temperature before attempting to remove; doing it while warm can cause the gelwax to tear apart.

PDMS

- Mixing
 - Weigh out, 1:10 is standard ratio (curing agent : PDMS Monomer)
 - Up to 1:40 for softer/tackier
 - Add any absorbers/scatterers to the curing agent first, then use sonication bath to help break up the small particles.
 - Degas for 5-10 minutes in vacuum chamber before/after pouring into mold. Best results will occur when using a large container so that you can let the vacuum go to it's max without the mixture overflowing.
- Curing
 - Release agent
 - Generally not needed, is mostly the case if using brand new glass or acrylic
 - If using glass or acrylic, make sure that it is extremely clean (use strong cleaners or solvents to get off any remaining residue)
 - If you do use a release agent, make sure to let it fully dry (at least 30 minutes) before casting as it can inhibit the curing process.
 - Can decrease cure time by putting in oven at 50-70C
 - For higher ratios (e.g. 1:40) may be better to let cure at room temperature first, then final cure for 1-2 hours in the oven (higher ratios may take longer to cure in general).
 - Note: The warmth of the oven may cause excessive leaking of the PDMS, notably from joints which didn't leak at room temperature.
 - Unless mold is completely water-tight, suggest to let it cure overnight and then bake for 1-2 hours once it has thickened up.
 - If cure inhibition (tackiness/stickiness) occurs, can heat up surface with blow torch (tested) or possibly bake at high temperature in oven (not tested)

Dragon Skin 20

- Make sure to mix each container thoroughly before using, some component of it seems to settle at the bottom
 - ¼" acrylic stirring sticks work okay, just make sure to dull edge, otherwise creates plastic shreds from scraping inside of bucket (if too many shreds form, they tend to float to the top over a day or two and can be skimmed off the surface)
- Using a release agent helped a bit, it didn't seem to stick too badly to the acrylic though even without using it

- Pot seemed to be a bit longer than the advertised 25 minutes; closer to 40 minutes from my experience
 - Despite this, you are still best off degassing the mixture as rapidly as possible. Generally I wouldn't waste time going through more than one vacuum cycle.

Optical Properties

- TiO_2
 - Typically at 0.72 g/L (equivalent of $\mu_s = 1 \text{ cm}^{-1} = 0.1 \text{ mm}^{-1}$)
- Ivory Black
 - 0.028 g/L (equivalent of $\mu_a = 0.1 \text{ cm}^{-1} = 0.01 \text{ mm}^{-1}$)

Liquid Scattering Phantom

- Scattering
 - Half and half milk
 - Lucerne Brand:
 - 75 g/L or 7.5% (equivalent of $\mu_{sp}' = 1 \text{ mm}^{-1}$)
 - Clover Brand:
 - 72.5 g/L or 7.25% (equivalent of $\mu_{sp}' = 1 \text{ mm}^{-1}$)
 - Horizon Organic Brand:
 - 70 g/L or 7.0% (equivalent of $\mu_{sp}' = 1 \text{ mm}^{-1}$)
 - Intralipid
 - 1141-100 mL Intralipid, 20% Emulsion Intralipid:
 - 32 g/L or 3.2% (equivalent of $\mu_{sp}' = 1 \text{ mm}^{-1}$)
- Absorption
 - India Ink
 - Higgins (non waterproof), diluted to 1%:
 - 11.6 g/L or 1.16% (equivalent of $\mu_a = 0.016 \text{ mm}^{-1}$)
 - Final concentration of India Ink in liquid phantom should be 0.116 g/kg
- Report & links to data: E0025 - Intralipid & India Ink Speckle Contrast Phantom
- Instructions
 - Starting with water, add 7.5% of half and half by weight to get the right reduced scattering coeff of $\mu_{sp}' = 1 \text{ mm}^{-1}$. (we are using a specific density of 1 => 1g=1ml). Then, use the 1% stock solution for india ink (again, 1g=1ml, 1% soln= 1g india ink, 99 ml water), and add enough to the scattering solution to make it 1.16% of initial soln.
 - The half and half (preferably Lucerne brand) is taken out of the refrigerator and kept at room temperature for 30 min prior to making the phantom.
 - Example calculations (half & half):
 - If making about 1500 ml soln, add 112.5 g half and half to 1387.5 ml water to make 1500 ml total soln.

- Then add 17.43 g of 1% stock solution of ink to the 1500 ml prepared scattering solution to make a total solution of 1517.43 ml (conc= $17.43/1500 = 1.16\%$).
- With 20% intralipid, the right concentration is found through experimentation to be 3.2%. Then, use the 1% stock solution for india ink (again, 1g=1ml, 1% soln= 1g india ink, 99 ml water), and add enough to the scattering solution to make a 1.16% soln.
- Example calculations (intralipid):
 - If making about 1500 ml soln, add 48 g 20% Intralipid to 1452 ml water to make 1500 ml total soln.
 - Then add 17.43 g of 1% stock solution of ink to the 1500 ml prepared scattering solution to make a total solution of 1517.43 ml.