

DIELESS DEPOSITION MANUFACTURING INSTRUCTIONS

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INTRODUCTION/SUMMARY



Approach #1: Breakaway Mold Walls

1. Print finger frames via 3D printer
2. Seal/tape finger frames
3. Prepare rubber urethane mixtures
4. Pour joint flexure urethanes
5. Pour finger pad urethanes
6. Wait for urethanes to cure (24-48 hours)
7. Cut away sacrificial walls

Step-by-step video also available at:
www.youtube.com/watch?v=dEJJMax7hs0



Approach #2: Multi-Part Molds

1. Print finger and mold parts
2. Assemble snap-together mold
3. Prepare rubber urethane mixtures
4. Pour joint flexure urethanes
5. Pour finger pad urethanes
6. Wait for urethanes to cure
7. Disassemble mold walls slowly (tabs are included on mold pieces to aid in disassembly)
8. Clean-up leftover urethane material

Step-by-step video also available at:
<http://www.youtube.com/watch?v=iqePcD0VAmc>



PROCESS COMPARISON

Breakaway Mold Walls	Multi-Part Molds
Minimizes material that needs to be printed	Requires full set of mold pieces for each finger
Requires band-saw post-processing	Has no sacrificial 3D-printed pieces
Requires ability to print thin (~0.7mm) sacrificial walls	Mold components have minimum 3mm feature size, which might make it easier for lower-end printers
Cannot be re-used, must re-print every time	Outer mold components are reusable
Single piece print, no inter-part dependencies	Mold components must fit together properly
Molds need to be sealed with tape	Mold pieces snap into place, no adhesives necessary
Possible urethane leakage due to tape not adhering properly to mold	Possible urethane leakage due to mold components not fitting tightly together
Smaller sacrificial pieces minimizes potential damage to flexures/pads	Care should be taken during mold disassembly to avoid pulling out finger pads



SELECTED URETHANES



Finger Joints:

- PMC-780 Urethane [\[link\]](#)
 - Two-part rubber compound
 - PMC-790 too stiff for general use cases
 - Demold time: 48 hours
- Alternatives:
 - Task 16 [\[link\]](#)



Finger Pads:

- Vytaflex-20/30 Urethane [\[link\]](#)
 - Two part urethane rubber
 - PMC-780 and other Vytaflex options can act as suitable replacements
 - Demold time: 16 hours
- Alternatives:
 - Econ 80 [\[link\]](#)

- Commercial rubber urethanes are mixed just like two-part epoxy
- Mix according to ratios in instructions, either by volume or mass
 - Mass scale will need 0.1g precision due to small quantity that is mixed
- Approximately ~5-8g of total urethane is needed per finger for each component
 - This will vary depending on your finger parameters and leakage



SEALING/TAPING



- Remove **all** support material prior to pouring
- **DO NOT** pour on top of support material
 - Urethanes will leak through support material
- Use tape to seal bottom of finger molds as shown above
 - Most adhesives will suffice
 - Some leakage is expected, not critical
 - Try to ensure that tape remains affixed to bottom of finger molds
 - Heating duct tape and masking tape are preferred



MOLD ASSEMBLY/DISASSEMBLY



- Mold components should fit snugly together and snap into the bottom plate
 - Printing errors between matching parts will increase urethane leakage
- Easiest to assemble all parts except for bottom plate first, then snap into the bottom place
- Easiest to disassemble by removing bottom plate first, then peeling away the side walls
 - Wall in contact with urethanes may be difficult to remove
 - Release agents like mold-release or wax may be applied to walls in contact with urethane to aid in removal



POURING

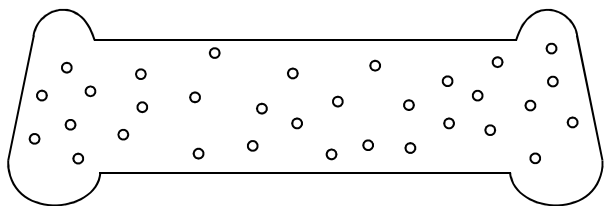


- Pour from as high and with as thin a stream as possible
- Pour more than necessary
 - Excess material can be cut off and removed later
 - Additional urethane may need to be poured if urethane leaks
- Less viscous urethanes have higher chances of leakage
 - Users can wait ~10 min for urethanes to become more viscous and easier to pour if desired
 - However, waiting too long before pouring may not give urethane enough time to set in the cavities, resulting in excess bubbles and poorly-formed flexures

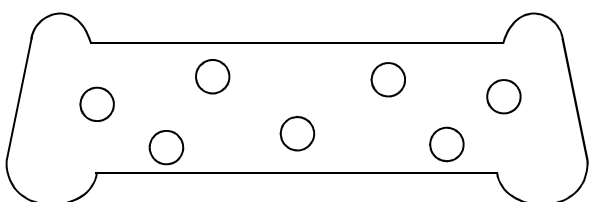
Tips/suggestions for pouring also available via the urethane distributor at www.smooth-on.com



DEGASSING (OPTIONAL)



Degas



No Degassing

Why Degas?

- More evenly distributed bubble/imperfection formation
- Higher density
- Higher stiffness
- Higher degree of manufacturing repeatability

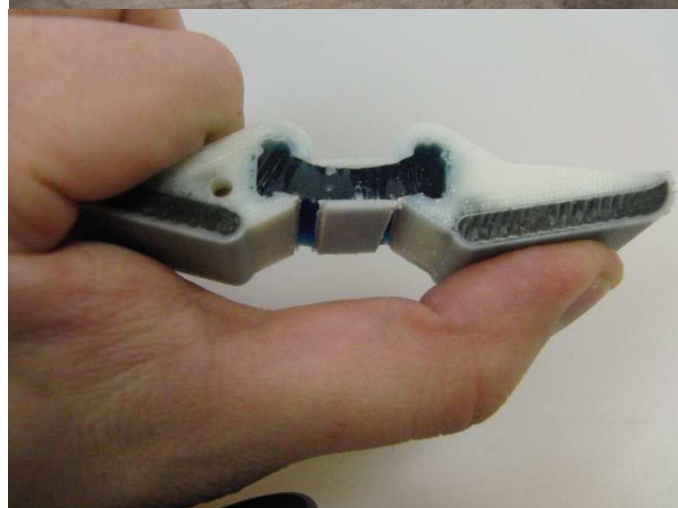
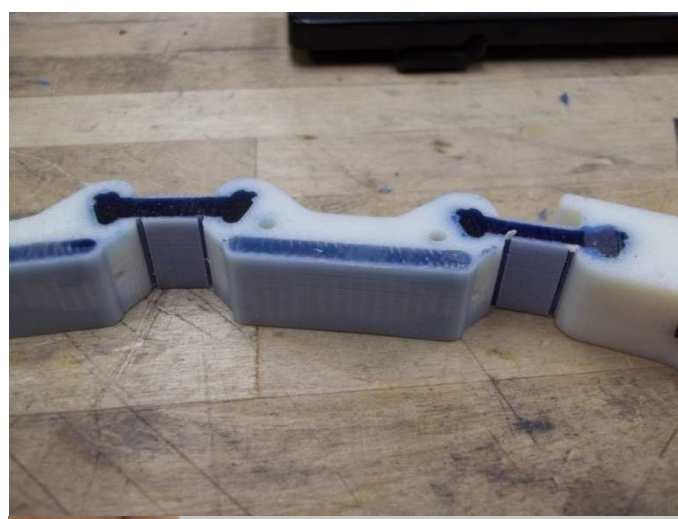


Solutions:

- [Low vacuum](#) in [dessicator](#) (see figure to the left)
 - Leave mixed urethane in vacuum for < 2 min
 - User should observe the urethane rise/fall
- Consider alternative urethanes that set more quickly
 - Alternative urethanes from those listed in this guide have not been tested in OpenHand projects



WALL REMOVAL



- ABS frame ~0.7-1.0 mm thick
 - Bandsaw or file used to cut out frame elements
 - Compliance of joints/pads minimizes damage if cut is excessive
 - Can partially cut and then “snap” frame elements apart
- File, blade, or belt sander can be used to smooth, file-down excess ABS or urethane material
- Be careful to avoid accidentally cutting into the flexure
 - Tears in flexure material will degrade performance and robustness
- Be careful to preserve tendon-entry holes during removal of walls from finger pads