

# Soft Lithography

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Microfluidic devices are constructed from a translucent, gas-permeable polymer and bound to a glass coverslip, which allows for observation using fluorescence microscopy. Polydimethylsiloxane (PDMS) is gas permeable (6x the air permeability of water), and has the unique property of having the same optical properties as water, which simplifies imaging of aqueous systems([Ferry, Razinkov, and Hasty 2011](#)).

## Mixing PDMS

1. Check wafer. If dirty, rinse with isopropanol (NO ACETONE) and blow dry with filtered N<sub>2</sub>.
2. Wrap wafer in a single layer of aluminum foil. Ensure a vertical rim of ~1" around the entire wafer. Wrap wafer so that when you pour PDMS, none of it leaks and collects between the wafer and the foil.
3. Add 3.5g of catalyst to 35g of PDMS base (1:10 ratio) in a weigh boat and mix thoroughly for 5 minutes. The mixture should go from clear to cloudy (due to the incorporation of air bubbles into the mixture).
4. Place the weigh boat in the desiccator and apply vacuum. The bubbles in the PDMS mixture should enlarge. Remove the vacuum to pop the bubbles. Repeat application and removal of vacuum until all bubbles are gone (it usually takes 20-25 mins to remove all the bubbles; if the bubbles are removed quickly then it may be a sign of the base being too old).
5. Pour mixed PDMS onto the foil-wrapped wafer. Place foil-wrapped wafer in desiccator.
6. Repeat cycles of vacuum application and removal to eliminate any bubbles in the PDMS.
7. Place wafer at 80°C for 2-12 hours.
  - Note: Overnight baking is beneficial during the spring, summer and fall, as the increased humidity negatively affects binding. The baking time can be decreased to 2 hours during the drier winter months.
  - Note: As PDMS becomes more rigid as it cures, the trap height for narrow devices can be modified slightly by changing the monolith baking time. Longer bake times can help with traps that bind to the coverslip (too low) and shorter baking times can help with high traps.

## Preparing Monolith

1. Remove wafer from 80°C oven. Let cool to room temperature.
2. Run a razor blade around the wafer, perpendicular to the surface of the wafer. Be careful to avoid digging the blade into the edge of the wafer. Remove aluminum foil from bottom of the wafer and then slowly lift monolith from wafer. The best way to remove the monolith is to lift to the middle, then move around the wafer and lift. Repeat until the monolith is freed from the wafer. Return wafer to storage.
3. Trim circular edges from the monolith using a sharp blade; do not drag the blade along the monolith surface, instead make single deep cuts into the monolith.
4. Cover both large sides of the monolith with parafilm.
5. Cut monolith into quarters.
6. Punch ports in each quarter with biopsy punch - either using the microscope after removing parafilm or you can look at the ports through the parafilm and punch without the microscope. Punch with the FEATURE SIDE up (punch through the feature side, not the other side).
7. Clean punched quarters with tape.
8. Dice individual chips.
9. Completely submerge chips in methanol in a crystallization dish.
10. Sonicate in methanol for 480 seconds (8 minutes)
11. Discard methanol and add new methanol
12. Sonicate again in methanol for 480 seconds (8 minutes)
13. Place chips at 80°C for 30 minutes
14. Remove chips from oven and let cool to room temperature before proceeding to binding

## Binding

The UV/O<sub>3</sub> oven has a maximum on time of 20 minutes, after which the efficiency of the UV lamp decreases. Effectively, this is one monolith worth of chips

After binding, the oven needs to cool for 30 minutes before another batch of chips can be bound.

1. Turn on O<sub>2</sub> to 0.4-0.5 scfm
2. Turn on UVO cleaner. Run UVO cleaner for 5 minutes to warm up.
3. Clean 24x40mm #1.5 coverslips by rinsing with isopropanol and blowing dry with N<sub>2</sub>.
4. Clean chips with scotch tape. Briefly: place tape on feature side of chip. Using finger nail, apply gentle pressure to features. Remove tape. Repeat twice more (3x total). Clean the other side with tape also
5. Place 2-4 chips (feature side up) and cover slips in UVO cleaner; place chips and cover slips on the far side of the tray (area of discoloration is the area of highest UV intensity). Run for 3 minutes.
6. Once done in UVO cleaner, quickly invert chips onto cover slips. Place them in the 80°C oven top shelf overnight