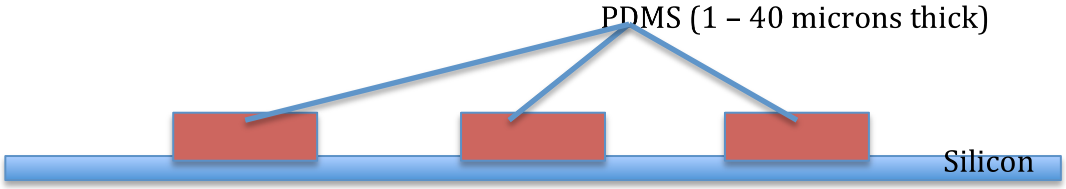
Greg Madejski McGrath Lab

Principles of Mold Making for Microfluidic Rapid Prototyping

PDMS is a very useful polymer for microfluidic testing, as it cures quickly and conforms to surfaces, allowing imprints to be made when fully crosslinked. SU-8 is a negative-acting photoresist (light exposure creates crosslinking in the resist) that can be machined to create very specific topographic patterns through lithography techniques. Below are the current method for making PDMS molds and a new proposed method for testing microfluidic chambers.

SU8 Manufacturer's data sheet
(www.microchem.com/pdf/SU-82000DataSheet2000_5thru2015Ver4.pdf)

1. Clean a wafer using RCA clean
2. Spin coat SU8 at desired thickness of topography onto wafer(consult Manufacturer's data sheet for baking times, spin speeds to create desired thickness)
    a. Example (40 microns thick):
        i. Prebake 140C for 2 minutes (optional, adhesion promoter sometimes applied here, HDMS)
        ii. Spin coat 1000rpm 2 minutes, 500 rpm/s ramp and deceleration
        iii. Softbake 95C for 5 minutes (evens out resist thickness)
3. Create a darkfield lithography mask (design a pattern, get a transparency custom ordered)
    a. Some masks have already been created (Barrett Design)
4. Expose SU8 with UV source illuminating the darkfield lithography maks (consult Manufacturer's data sheet for exposure times, dose to crosslink)
    a. 150-160 mJ/cm^2 for 40 micron thickness. Have to know power of UV source to get exposure time
5. Post exposure Bake (smooths out exposure pattern in the photoresist)
    a. 95C for 6 minutes for 40 micron thickness
6. Develop with SU8 developer solution
    a. 4-5 minutes for 40 micron thickness, then rinse with IPA and dry with Nitrogen Gun
7. Hard Bake (destroys photosensitivity in most resists, preventing further exposure, further increases crosslinking)
    a. 150-250C for 30 minutes, depending on the temperature of processing PDMS
8. Mold is complete

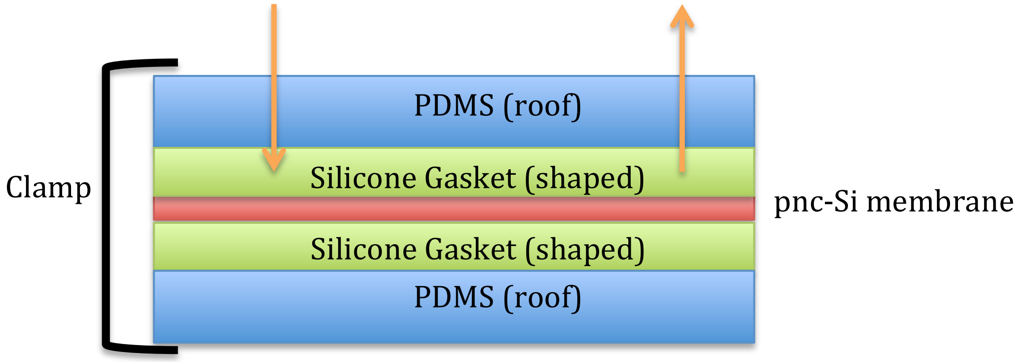


Advantages
- Mask is reusable to create same PDMS mold, when cured on it.
- Small accurate geometries are easily reproduced (micron scale thickness and area control)

Disadvantages
- Irreversible pattern creation (silicon can't be reused if you want to change the pattern
- Complicated processing to create mold

Silicone Gasket Method

The main thrust behind this method is to remove the need to create PDMS molds and instead use custom made silicone gaskets to shape fluidic flow. These gaskets are constructed much easier than the molds described above. The overall film stack might look like the image below, where the silicone gasket provides the microfluidic structure across the membrane, and the PDMS simply seals the fluidic chamber on both sides.



Advantages:
- Much easier fabrication of gasket and PDMS roof compared to mask making
- Many more heights available
- Easier assembly of fluidic device

Disadvantages
- Clamping method unproven, may leak
- No good way to access the bottom chamber