I. Bulk Hydrogel Fabrication

Bulk hydrogel can be easily fabricated by mixing the pre-polymers and cross-linking the pre-polymers. As bulk hydrogels typically don't have stringent shape requirements and can be casted in molds, bulk hydrogels can be cross-linked using either thermal- or photo- methods.

A. Mixing pre-polymers

The hydrogel pre-polymer solution consists of 3 key ingredients – monomers, initiators, and cross-linker. Initiators generates free radicals and elongates monomers into polymers, while cross-linkers binds nearby polymers into 3-D scaffolds. Many monomers come in liquids, but most initiators are powers. Therefore, we need to add all chemicals into certain common solvents, fully dissolve the powers, and thoroughly stir the chemicals. Once a pre-polymer solution is prepared, it is recommended to be used within a few days to prevent unwanted premature crosslinking. It is also recommended to add initiators only before final crosslinking.

Step-by-step instruction preparing HEMA-DMAEMA hydrogel [1] is listed below. While the original paper uses thermal crosslinking method for bulk fabrication, the bulk recipe is adapted for photo-crosslinking method here.

Materials:
HEMA (2-hydroxyethyl methacrylate; monomer; liquid)
DMAEMA (N,N-dimethylaminoethyl methacrylate; pH-responsive monomer; liquid)
TEGDA (tetraethylene diacrylate; cross-linker; liquid)
DMPA (dimethoxy-phenylacetophenone; photoinitiator; powder).

All materials should be approved by SNF staff member and come with yellow label. Listed ratios based on [1] can be adjusted based on your need. In general, more DMAEMA increases the pH sensitivity. More TEGDA increases the crosslinking efficiency but makes the hydrogel stiffer. We also removed PEG from the original recipe to prevent chemical crashing (see "General FAQ").

Lab space:
exfab-wbsolve, wafer saw room laura-wb, NSIL fumehood 1.
Equipment:
weighing scale, weighing paper, 25ml graded glass cylinder x 2, 50 ml glass beaker, amber jar, pipette controller, matching pipette tips x several, waste container bag, waste disposal bottle, paraffin film. All materials should have a blue card to record safety information.

At exfab-solve:

1. Put a clean 25mL graded glass cylinder on the weighing scale, gradually pipette into 13.01g (0.1mol) of HEMA. Change pipette tip.

2. Pipette 3.93g (0.025mol) of DMAEMA and 0.567 g (0.001875 mol) of TEGDA into the same cylinder in 1. Measure the total volume by looking at the bottom curve of the liquid surface, mark the volume as V1. Change pipette tips in between.
3. Put another clean 25mL graded glass cylinder on the weighing scale, pipette 50% V1 of DI water.
4. Mix the solutions from 2 and 3 in a 50mL glass beaker. Measure the total weight as W. The solutions will look cloudy at the beginning but should clear up after light shaking.
5. Transfer the solution to an amber jar. Close the cap tightly and seal with paraffin film. Label the jar with chemical names and ratios.
6. Rinse all glassware, collect all solid waste in a plastic waste container bag, collect waste chemicals in a waste disposal bottle and return to the waste disposal pickup shelf.

At wafer saw room laura-wb:

7. Transport the amber jar of hydrogel pre-polymer with a secondary container basket.
8. Fully cover all windows with aluminum foil. Turn on the yellow light at laura-wb. Leave a sign on the door and close the door. Turn off all white lighting.
9. Weigh 2% of W1 of DMPA powder, directly add to the amber jar.
10. Clean up the waste and return the room to original condition.
11. *If doing thermal crosslinking, you can directly add the powder to solution in the NSIL room.*

At NSIL fumehood 1:

12. Stir with magnetic stirrer or shaker table in the fumehood for at least 4 hours, or use the vortex mixer for 10 min with smaller volumes. Powders should be fully dissolved.
13. Store the solution in the solvent fridge in the maintenance area for up to 3 days. Because the solution is light sensitive now, it should be stored in amber jar or wrapped with aluminum foil.

B. Cross-linking

Hydrogel can be crosslinked either thermally or optically. Bulk pieces can be casted into molds such as cell plate. Slightly thinner bulk films (100um to 500um) can be made by pipetting pre-polymer between glass slides with spacer in between. See Figure 2.

Lab space:

exfab-wbsolve, UV-cure (at SNF litho area)

Equipment:

Glass slides, mylar films or silicon gaskets, pipette

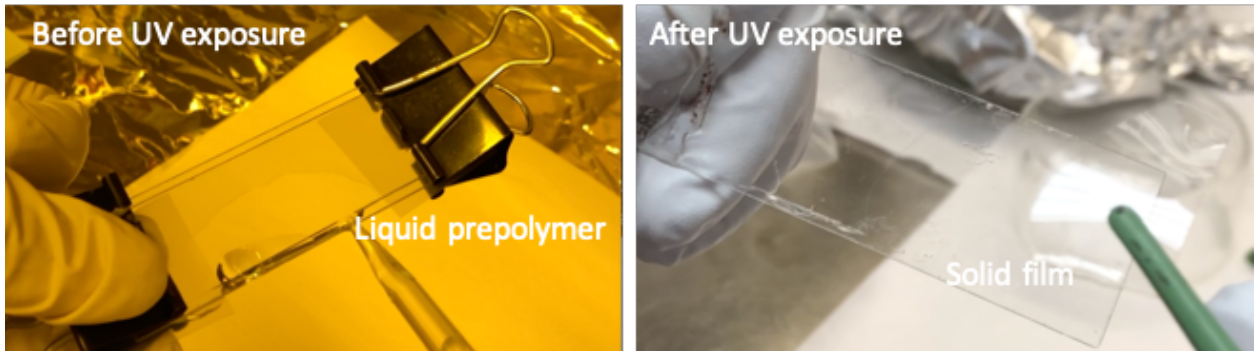

Fig. 1. Hydrogel in liquid and solid format before and after UV exposure.

Molding at exfab-wbsolve:

1. For large bulk pieces of hydrogel (cm scale): Pipette a known amount of pre-polymer into the cell plate or mold.
2. For thinner bulks (50um or thicker):
    a. Rinse 2 pieces of glass slides. Blow dry with N2.
    b. Use a mylar films (or silicon gaskets) with known thickness as spacer, insert between the glass slides.
    c. Fix the glass slides and spacer layer with tapes or clips. Make sure the glass slides are off set a little bit so it's easier to insert pipette tip's head.
    d. Pipette pre-polymer in between the glass slides, minimizing bubble formations.

Photo-crosslinking at UV-cure:

1. For photo-crosslinking, you can use either the UV-cure in the all-litho area or use an UV lamp. 10 minutes is enough.
2. Keep hydrogel under DI water immediately.

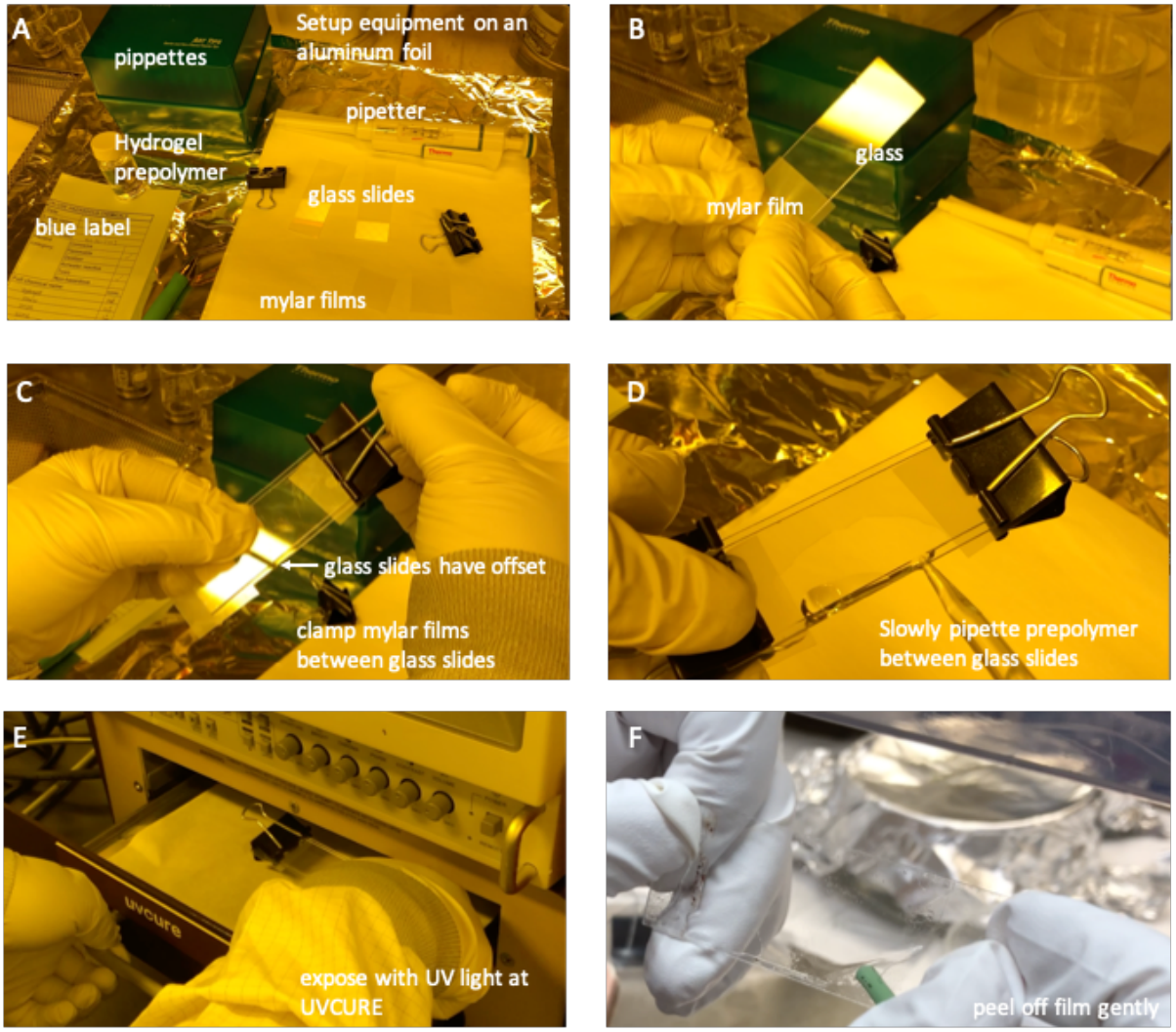

Fig. 2. Fabrication steps for bulk hydrogel fabrication.