

# Polydimethylsiloxane (PDMS) on SU-8 Mold

## Standard Operating Procedure

Faculty Supervisor: Prof. Robert White, Mechanical Engineering (x72210)

Safety Office: Peter Nowak x73246 (Just dial this directly on any campus phone.)

(617)627-3246 (From off-campus or from a cell phone)

Tufts Emergency Medical Services are at x66911.

For more information on this popular process, see the many papers by Whitesides, for example:

David C. Duffy, J. Cooper McDonald, Olivier J. A. Schueller, and George M. Whitesides, "Rapid Prototyping of Microfluidic Systems in Poly(dimethylsiloxane)" *Anal. Chem.* 70, 1998. pp. 4974-4984.

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**Caution:** Uncured PDMS is a viscous, sticky, oily liquid that will easily contaminate exposed surfaces. Vacuum chambers in particular are extremely sensitive to uncured PDMS, often with dire consequences. Please use Aluminum foil as described in section 2.2, exercise care during processing, change gloves frequently and clean up when you are finished.

## 1. Material Requirements:

- 1.1 Equipment: 4" wafer tweezers, polystyrene Petri dish, 2 pipettes, plastic spoon, plastic cup, razor blade, vacuum desiccator, Plasmod O<sub>2</sub> plasma asher, aluminum foil, hot plate, scale.
- 1.2 Preparation: You must prepare the SU-8 mold wafer prior to beginning the PDMS process. This procedure is dealt with in a separate SOP.
- 1.3 Chemicals: PDMS, and silanizing agent (tridecafluoro-1,1,2,2-tetrahydrooctyl trichlorosilane)
  - 1.3.1 Hazards associated with chemicals:
    - 1.3.1.1 PDMS: May cause eye and skin irritation. May cause respiratory and digestive tract irritation.
    - 1.3.1.2 Silanizing Agent: Corrosive. Causes sever irritation and burns. Harmful if ingested, inhaled, or absorbed through the skin. Lachrymator.  
**\*\* Reacts violently with water releasing hydrogen chloride (HCL). Incompatible with oxidizing agents, acids, alcohols, and bases. \*\***
- 1.4 Engineering Controls: Conduct procedure in ventilated fume hood. Store bottles of chemicals (sealed tightly) in cabinets with secondary containment. Work area should contain an eye wash and safety shower.
- 1.5 Personal Protective Equipment: Nitrile gloves, apron, and goggles. While working in the hood, also use trionic gloves.

## 2.0 Procedure:

### Complete all processes in the fume hood.

#### 2.1 SU-8 Silanization – passivation of surfaces to aid release from PDMS:

- 2.1.1 Using wafer tweezers, place the SU-8 mold wafer along with 2-3 drops (use pipette) of the silanizing agent in a Petri dish and put in vacuum desiccator.
- 2.1.2 Attach the desiccator to a vacuum hose on the hood vacuum port. Open the faucet-style vacuum valve. Leave the wafer under vacuum for at least 1 hour.

#### 2.2 Mix and Degas PDMS:

- **Silicone raw material is very sticky. Tape a piece of aluminum foil down inside the fume hood to act as a disposable work space. Place a piece of foil on top of the scale as well.**

- 2.2.1 Bring the scale into the fume hood. Place a plastic cup and spoon onto the scale and tare.

- 2.2.2 Using the spoon to dispense the PDMS base and a pipette for the curing agent, weigh the PDMS pre-polymer components in a 10:1 (base:curing agent) ratio into the cup. Add the base first, making sure to weigh without the spoon in the cup. Pour a volume of base that is about equal to the total volume. Add the curing agent next with the pipette. Mix well with the spoon (until mixture is milky due to air bubbles).
- 2.2.3 Turn off vacuum and remove the SU-8 wafer from the desiccator.
- 2.2.4 Put the PDMS mixture (in the cup!) into the desiccator and turn the vacuum back on. De-gas the mixture under vacuum until no bubbles appear (20~30 min). **Make sure the PDMS mixture does not foam out of the container.** When large bubbles form at the surface, vent vacuum to pop bubbles.

### 2.3 Pour PDMS:

- 2.3.1 Carefully pour the PDMS over the SU-8 master wafer already located in the polystyrene Petri dish.
- 2.3.2 Try to minimize introduction of bubbles.

### 2.4 Cure PDMS:

- 2.4.1 PDMS will cure without heating in ~24 hours.
- 2.4.2 To decrease cure time, place the Petri dish onto a hot plate (still in the Petri dish!) set at 65°C for ~1-2 hours (depending on the thickness of the PDMS layer).
- 2.4.3 After curing, the wafer is stable and may be stored for months if necessary.

### 2.5 Remove Mold:

- 2.5.1 Using tweezers (and a razor if necessary), carefully peel off the PDMS mold from the SU-8 master.
- 2.5.2 Cut the mold into the desired shape using razor blades, being careful to keep the mold clean.

### 2.6 Clean Up

- 2.6.1 Return all labware to the proper location.
- 2.6.2 Remove aluminum foil and wrap up all used materials and scraps. Discard in the photoresist waste container.

### 2.7 Oxidize Surfaces (if further bonding is required):

-- Read the March Plasmod SOP and the PDMS-Glass Bonding SOP before operation of asher.

- 2.7.1 Place the PDMS and glass pieces being bonded into the Tegal Plasmod plasma cleaner with the surfaces to be bonded facing up.
- 2.7.2 Turn on the plasma cleaner and once plasma is stable, ash for 30 seconds.
- 2.7.3 The plasma oxidizes the surfaces creating dangling bonds which allow the PDMS to bond covalently to the glass. Over-ashing should be avoided due to a reduction in bond strength.

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### 3.0 Storage:

- 3.1 Store PDMS components in the photoresist storage cabinet.
- 3.2 Store silanizing agent in solvents storage cabinet.

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### 4.0 Waste Disposal:

- 4.1 Aluminum foil, cups, spoons, Petri dish, and wipes with PDMS on go in solvent/photoresist waste container.
- 4.2 There should not be any silanizing agent left over... it should have evaporated away. If it has not, allow it to evaporate away in the hood and dispose of the container in solvent/photoresist trash.
- 4.3 Razor blades, broken glass or broken silicon waste goes in the "sharps" waste.

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#### **5.0 Accident Procedures:**

- 5.1 Contact: Read MSDS prior to working with any chemical to familiarize yourself with the symptoms of exposure and recommendations for treatment.
  - 5.1.1 Skin contact: Flush with water.
  - 5.1.2 Eye contact: Flush with copious amounts of water for 15 minutes.
  - 5.1.3 Ingestion: Do not induce vomiting. If conscious and alert, rinse mouth and drink 2-4 cupfuls of milk or water.
  - 5.1.4 Inhalation: Remove to fresh air. Resuscitate if necessary.
- 5.2 Spill:
  - 5.2.1 Any small spills should be wiped up immediately with wipes. Dispose the wipes in the photoresist waste container.
  - 5.2.2 In case of large spill that you are not comfortable cleaning up, evacuate the lab and contact the lab manager and/or safety office.

If at any time you feel a situation is dangerous, do not hesitate to call the safety office (x73246, Peter Nowak), the faculty supervisor/lab manager (x72210, Robert White).

**Report all accidents (injuries, major spills, fires) to the safety office at x73246 (Peter Nowak). For emergencies, call Tufts Emergency Services at x66911.**