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PDMS Microfluidic Device Fabrication

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Abstract

A protocol used to generate a PDMS microfluidic chip. Work was funded by Cambridge Synthetic Biology Strategic Research Initative (SRI) SynBio Fund.
http://www.synbio.cam.ac.uk/synbiofund

Guidelines

Materials

- SU-8 photoresist (MicroChem, SU-8 2025)
- Propylene glycol monomethyl ether acetate (PGMEA; Sigma-Aldrich, cat. no. 537543)
- Poly(dimethyl siloxane) (PDMS) and curing agent (Dow Corning, Sylgard 184)
- Silicon wafers (3-inch diameter, Type-P, 1S polished; University Wafer, cat. no. S3P01SP)
- Isopropanol (Sigma-Aldrich, cat. no. 278475)
- 1H,1H,2H,2H-Perfluorododecyltrichlorosilane (Sigma-Aldrich, cat. no. 729965)
- HFE-7500 (3M, cat. no. 98-0212-2928-5)
- Pico-Surf (TM) 1, 10ml, 5% in Novec 7500 (Dolomite, cat. No. 3200214)
- Miltex® BIOPSY PUNCH WITH PLUNGER 1.0mm (Williams Medical Product Code D6345 Mfg. Code SCH-33-31AA-P)
- Hamilton gas-tight syringe, 0.5 ml (Hamilton, cat. no. 201300)
- TUBING,POLY,20PE,30m (Harvard apparatus, cat. no. 59-8324)
- Petri dishes (100 mm diameter × 15 mm
- Glass slides (75 × 50 mm)
- Scalpel
- Sharp tweezers

Before start

1. Use AutoDesk AutoCAD to design the microfluidic pattern printed on a photolithography mask.
2. Order photolithograph masks from Microlitho Services (http://www.microlitho.co.uk/)

1 Use SU8 2025 for the master of the microfluidic device. To make the microfluidic device with 50 µm deep channel, follow the manufacturer's processing guidelines available online (http://www.microchem.com/Prod-SU8_KMPR.htm).

2 Place the wafer into the spin coater and dispense ~5 ml of SU-8 2025 onto the centre of the silica wafer.

3 Start the spin coater with the following program: 5 s at 500 rpm and thereafter 40 s at 1450 rpm.

4 Prebake the spin-coated silica wafer by placing it on a 65 °C.

5 Bake the silica wafer at 95 °C.

00:06:00

6 Leave the silica wafer substrate to cool to room temperature.

7 Place the photolithograph mask on top of the substrate and expose the silica wafer with UV light from MJB4 for 7.5s (exposure energy ~10 mJ cm^{-2}).

8 Incubate the silica wafer substrate on a 65 °C hot plate.

00:01:00

9 Transfer the silica wafer substrate to a 95 °C hot plate and incubate.

00:03:00

10 Leave the silica wafer substrate to cool to room temperature.

11 Immerse the wafer into the PGMEA liquid and make sure it is completely covered by developer.

00:04:00

12 Rinse the wafer with isopropanol and then dry the silica wafer with nitrogen.

13 To improve the adhesion of SU-8 to the silica substrate, place the silica wafer on a 170 °C hot plate.

00:05:00

14 Place the completed master silica wafer in a plastic Petri dish.

15 Weigh 30 g of PDMS base and 3 g of curing agent (10:1 ratio) and mix well.

16 Pour the PDMS mixture into the Petri dish about 6 mm deep and place the Petri dish in a vacuum desiccator to remove the bubbles.

17 Bake the PDMS in a 65 °C oven.

04:00:00

18 Cut PDMS slab with a scalpel and gently peel the PDMS from the silicon wafer.

19 Use a biopsy punch to create hole for the fluid inlet and outlet.

20 Place the PDMS slab and the glass slide in the plasma chamber with the channel side facing upward.

21 Using the following settings to treat both PDMS slab and the glass slide with oxygen plasma.
power = 1

00:00:10

22 Gently bring plasma-treated slab and the glass slide together so that all parts are sealed to the glass.

23 Place the microfluidic device in a 110 °C oven.

02:00:00

24 Leave the microfluidic to cool to room temperature.

25 Use 1% (vol/vol) perfluorododecyltrichlorosilane in Novec 7500 solution to fill the microfluidic channel.

26 Place the microfluidic device in a 65 °C oven.

12:00:00

27 Leave the microfluidic to cool to room temperature and cover with Scotch tape to keep dust from the openings.