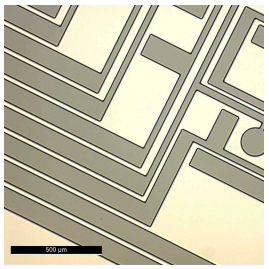
Feb 01, 2023

Photolithography for microfluidics



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Protocol status: Working
We use this protocol and it's working

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Abstract

Photolithography for microfluidic mold fabrication, successfully tested at the Scottish Microelectronics Centre. Produces rounded flow layer using positive resist SPR 220-7 with ~12um features, and rectangular control layer using negative resist SU-8-3035 with ~35um features).

Adapted from **dx.doi.org/10.17504/protocols.io.46wgzfe** / Laohakunakorn et al. 2021 (https://doi.org/10.1007/978-1-0716-1032-9_9).

Materials

- Masks: from Compugraphics. Master-Si, NFR5009, grade 2160A2.

1X Master, Soda Lime, 5"x5"x0.09"
Minimum critical feature: 2.0um
Defect density: 1 per in^2 (0.2 per cm^2)
Registration: SPC
CD tolerance: 0.25um
Defect size: 2um
Data design: rectilinear
Write area: 1" smaller than mask size

Compugraphics product code: 2160A2

Flow layer (SPR220, positive resist)
Digitised data = **Dark**
Data parity chrome up = **Wrong**
Title parity chrome up = **Wrong**
CD size = SPC
Data top cell = TOP
Data format = CIF
Data window = Compugraphics default

Control layer (SU8, negative resist)
Digitised data = **Clear**
Data parity chrome up = **Wrong**
Title parity chrome up = **Wrong**
CD size = SPC
Data top cell = TOP
Data format = CIF
Data window = Compugraphics default

Double-check these settings very carefully!

- Wafer properties: from Inseto.

Diameter: 100mm
Material: Si
Type: N
Orientation: 100
Dopant: P-doped
Grade: Test?

Lower resistivity: 1 ohm.cm
Upper resistivity: 10 ohm.cm
Thickness: 525 um
Polish: SSP

Troubleshooting

Flow Layer

1 **HMDS priming**

1.1 Prime a clean Si wafer in a sealed box with HMDS for 00:10:00 10m

2 **Prebake**

2.1 Transfer to hotplate and carry out pre-bake at 120 °C for 00:12:00 . 12m

3 **Spin coat with SPR 220-7 (Megaposit)** SPR_220_DATA_SHEET_RH.pdf

3.1 Transfer wafer to spin coater and run following programme using SPR 220-7 resist: 2m 10s
1. 400 rpm, 00:00:30
2. 1000 rpm, 00:01:40
at 200 rpm/s. This coats the wafer with ~12 um.

4 **Softbake**

4.1 Transfer to hotplate and carry out soft-bake at 105 °C for 00:06:00 . Remove promptly when done. 6m

5 **Exposure**

5.1 Expose with the following settings (for a Karl Suss MA8 mask aligner): 1m 30s

Multiple exposure steps: [00:01:20 exposure + 00:00:10 wait] x 2 cycles, for a total of 160s (=638mJ/cm^2)

WEC=cont
Expose type = prox

40um alignment gap
5um expose gap
WEC offset OFF
N2 purge NO

The Karl Suss machine has a flux of 3.99 mW/cm^2 as measured from last maintenance. We would like an exposure of 660 mJ/cm^2.

5.2 Wait: leave the wafer in a sealed wafer box for 02:00:00 . 2h

6 **Post-exposure bake**

6.1 Transfer to a hotplate and hold at 110 °C for 00:05:00 5m

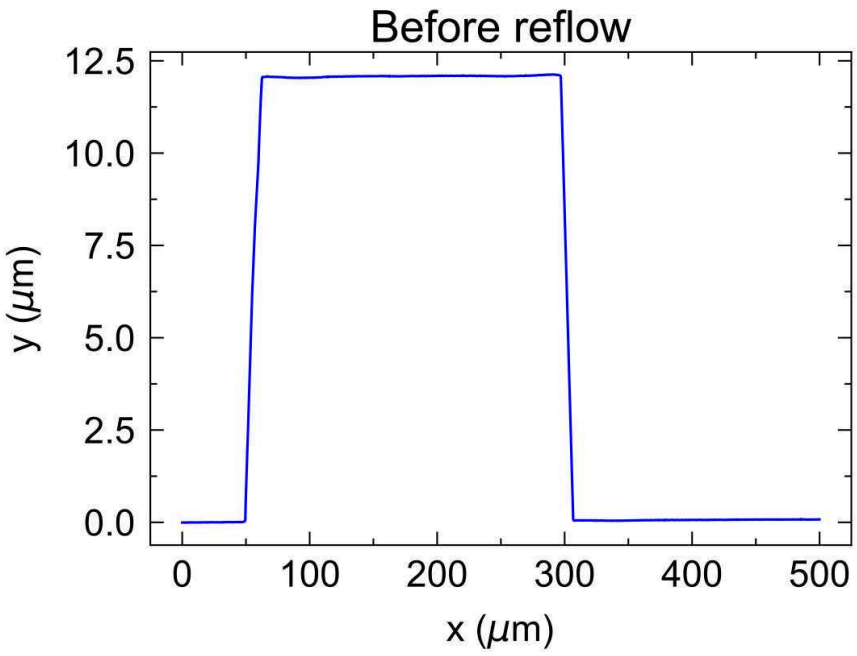
6.2 Wait: leave the wafer in a sealed wafer box for 00:45:00 45m

7 **Develop with MF26A**

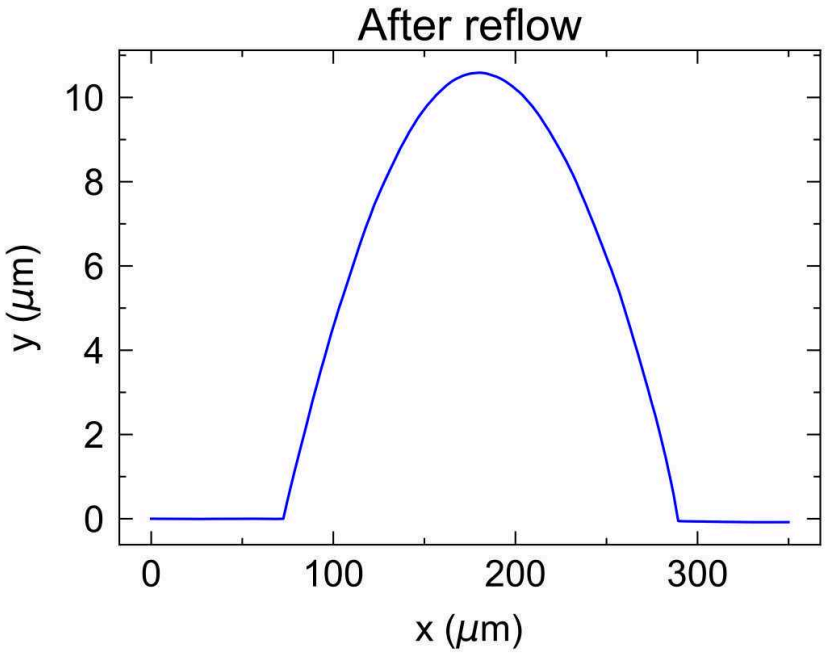
7.1 Develop right side up for up to 00:05:00 , rinse with DI water, and dry gently with compressed N2. 5m

8 **Reflow**

8.1 Place the wafer on a hotplate at room temperature, then ramp up to 170 °C (at a ramp rate of ~0.5*C/s). Hold at 170 °C for 00:40:00 , then turn off hotplate and allow to ramp down to room temperature (takes a few hours). 40m



Before reflow



After reflow

Control layer

1h 22m 40s

9 **O2 plasma treatment**

9.1 Treat with O2 plasma for 10 minutes in barrel asher. (At SMC, Electrotech 508 with typical parameters: forward power 350W, flow 32%, pressure 0.8 torr)

10 **Spin coat with SU-8-3035 (Kayaku)** KAM-SU-8-3000-Datasheet-7.10-fi...

10.1 Spin coat with SU8-3035 using the following programme with ramp rate of 100rpm/s for all steps: 1m 51s

1. 500 rpm, 00:00:10
2. 3000 rpm, 00:01:05 = 25s ramp + 40s hold
3. 4000 rpm, 00:00:01
3. 3000 rpm, 00:00:05
3. 0 rpm, 00:00:30

Make sure the spin coater has a plastic liner installed. If necessary clean back and edge of wafer with wipe soaked in PGMEA.

11 **Softbake**

11.1 Place on hotplate for 00:12:30 at 95 °C 12m 30s

Let wafer come to room temp (few mins) before exposure. If there are wrinkles, place on hotplate until wrinkles disappear.

12 **Exposure**

12.1 Expose with the following settings (for a Karl Suss MA8 mask aligner): 28s

Multiple exposure steps: [00:00:18 exposure + 00:00:10 wait] x 5 cycles, for a total of 90s (=359mJ/cm^2)

WEC=cont
Expose type = soft
30um alignment gap

5um expose gap
WEC offset OFF
N2 purge NO

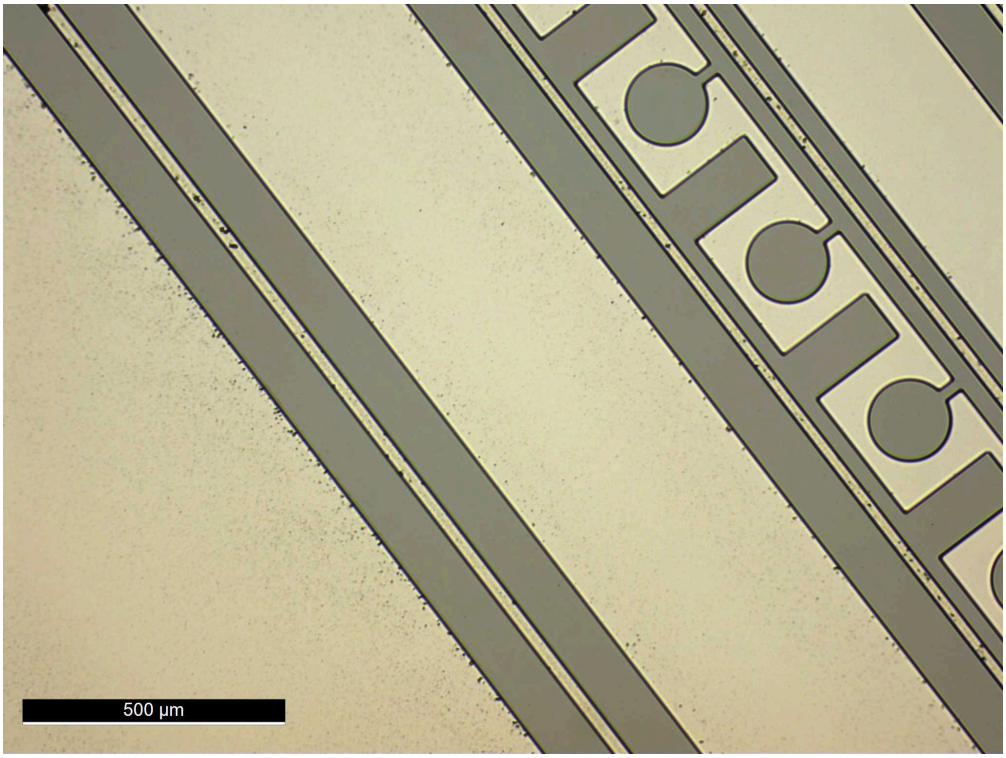
13 **Post-exposure bake**

13.1 a. Place on hotplate at 65 °C for 00:01:00 . 5m
b. Move to second hotplate and hold at 95 °C for 00:04:00 .

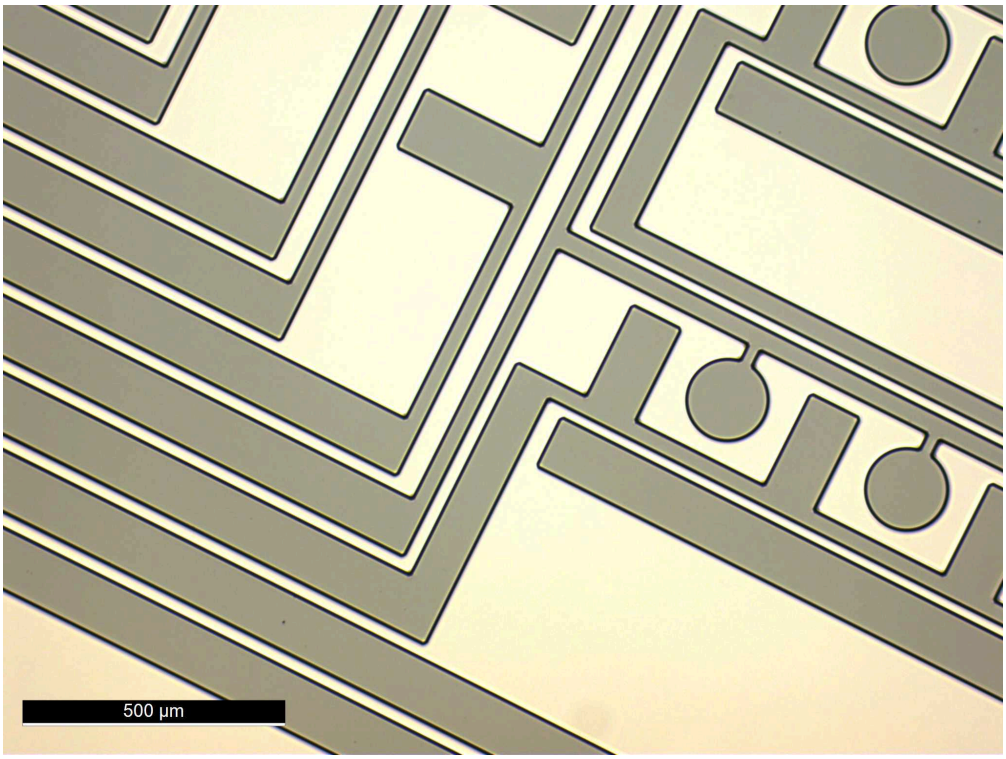
14 **Wait** for a minimum of 00:10:00 . 10m

15 **Develop**

15.1 Develop upside down in PGMEA for 00:02:00 , and exchange with new PGMEA for a further 00:02:00 . Check for underdevelopment each time on the microscope (white film). If necessary continue development for up to 6 min. 4m



Underdevelopment after 2+1 min



Correct development after 2+2 min

15.2 Rinse with IPA and dry gently with compressed air.

16 **Hardbake**

16.1 Ramp to 135 °C , and hold at 135 °C for 02:00:00 . 2h

Silanization of wafers

17 Silanization must be carried out before first use, to prevent PDMS sticking to wafers. Leave 500 µL of chlorotrimethylsilane (Sigma 386529) in an upturned Falcon cap, inside a sealed box with the wafers until the solvent has completely evaporated.