Channel Shape Study Report

Updated on 06/20/2015

Critical Factors

- When using an SU-8 base layer as a wafer pretreatment, the base layer must undergo a post-exposure bake or else the fabricated channels will take on a rounded characteristic.
- The rounded channels seem to be unique to using a base layer of resist under the feature layer by skipping the post-exposure bake step for the base layer.

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Goal

Test various wafer pretreatment conditions' effect on exposed and developed channel shape.

Materials

- SU-8 2005 (produced by thinning SU-8 2050)
- SU-8 2025 (produced by thinning SU-8 2050)
- SU-8 thinner
- SU-8 developer
- 3 inch diameter silicon wafers
- Line photomask (transparency film)
    - 10 µm channels, 50 µm troughs ("10x50")
    - 25 µm channels, 50 µm troughs ("25x50")
- Isopropyl alcohol (IPA)
- Acetone
- Buffered oxide etchant (BOE) in HF hood. **You must be HF hood trained before working with BOE. Speak with Eric Johnston or Kyle Keenan to arrange training.**
- PDMS/PDMS Curing Agent

Equipment

- Laurell Spinner
- Hot Plate
- ABM Mask Aligner
- Vacuum Chamber
- Optical microscope

Protocol

Preparation of SU-8 2005/2025 equivalent from SU-8 2050 stock

1. Weighed out SU8-2050
2. Calculated weight of thinner to add via:
    a. Wthinner = [(% solids initial / % solids final) – 1]*Wresist
3. Mixed with glass stirring rod in beaker for ~ 10 min until homogeneous
4. Aliquoted using Teflon funnel into resist bottles
5. Allowed bottles to degas by resting at RT overnight
6. Long-term storage of bottles in resist cabinet

Wafer pretreatments tested

1. 2 min BOE wash + 2 min rinse in overflow bath + nitrogen blow-dry + minimum 10 min dehydration 200 ºC
2. Dehydration for at least 10 minutes at 200 ºC + spinning and blanket exposing a 5 µm base layer of SU-8 of various thicknesses underneath the feature layer
    a. No post-exposure bake after exposing base layer and spinning feature layer
    b. With post-exposure bake after exposing base layer and spinning feature layer

SU-8 spinning (27 µm)

1. Set spin parameters:
    a. Vacuum = "req"
    b. Step 1 of 2: 500 rpm, accel = "100", 30 sec
    c. Step 2 of 2: 3000 rpm, accel = "300", 30 sec
        i. F40 Filmetrics measurement indicates these settings result in an approximately 27 um thick layer of resist
2. Mounted wafer and ensured that it is centered
3. Poured SU-8 2025 photoresist without air entrapment to ~ 50 mm diameter
4. Spun the wafer
5. Transferred spun wafer to 95 ºC hot plate for 5 min soft bake
6. If performing multiple spins, wiped spinner hood between wafers to prevent excess SU8 from dripping onto samples

SU-8 spinning (5 µm)

1. Set spin parameters:
    a. Vacuum = "req"
    b. Step 1 of 2: 500 rpm, accel = "100", 30 sec
    c. Step 2 of 2: 3000 rpm, accel = "300", 30 sec
2. Mounted wafer and ensured that it is centered
3. Poured SU-8 2005 photoresist without air entrapment
4. Spun the wafer
5. Transferred spun wafer to 95 ºC hot plate for 2 min soft bake
6. If performing multiple spins, wiped spinner hood between wafers to prevent excess SU8 from dripping onto samples

Resist exposure and development

Pretreatments 1

1. Started the ABM UV lamp (channel A) and allowed at least 20 min for warm-up
2. Computed required exposure time based on exposure energy values given on SU-8 data sheets
    a. ABM power output can be measured with the power meter or a recent value can be found in the log located in the ABM Operating Procedure binder
    b. $Exposure\ time = \frac{Exposure\ energy\ needed}{ABM\ power\ output}$
3. Mounted wafer and photomask
4. Contacted to Omega optical filter with leveling
5. Exposed lines for calculated exposure time
6. Post-exposure bake:
    a. 1 min at 65 ºC
    b. 5 min at 95 ºC
7. Developed in bath of SU-8 developer for 5 min with periodic agitation
8. Rinsed in acetone followed by IPA and nitrogen blow-dried

Pretreatment 2

1. Started the ABM UV lamp (channel A) and allowed at least 20 min for warm-up
2. Computed required exposure time based on exposure energy values given on SU-8 data sheets
    a. ABM power output can be measured with the power meter or a recent value can be found in the log located in the ABM Operating Procedure binder
    b. $Exposure\ time = \frac{Exposure\ energy\ needed}{ABM\ power\ output}$
3. For base layer:
    a. Mounted wafer
    b. Exposed wafer for calculated exposure time
    c. Post-exposure bake:
        i. None for Pretreatment 3a (no PEB)
        ii. 3 min at 95 ºC for Pretreatment 3b
4. For feature layer:
    a. Mounted wafer and photomask
    b. Contacted to Omega optical filter with leveling
    c. Exposed lines for calculated exposure time
    d. Post-exposure bake:
        i. 1 min at 65 ºC
        ii. 5 min at 95 ºC
    e. Developed in bath of SU-8 developer for 5 min with periodic agitation
    f. Rinsed in acetone followed by IPA and nitrogen blow-dried

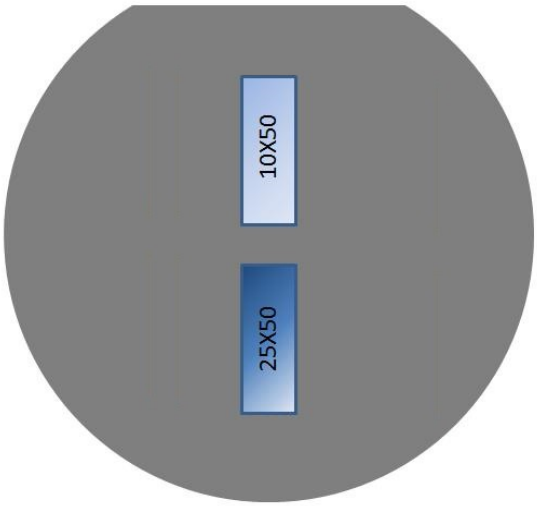

Figure 1: Schematic of wafer exposure for all pretreatments.

PDMS Casting and Peeling

- Placed wafers in aluminum foil dishes of appropriate depth
- Mixed ~ 50 g of PDMS at 10:1 base:cure by weight ratio per wafer and degassed under vacuum until clear (~ 45 min)
- Poured PDMS to a depth of 7 mm over each wafer on a level aluminum block
- Transferred block to preheated 100 ºC convection oven
- Cured PDMS for 70 min
- Allowed wafers to cool to RT
- Using a new razor blade manually excised PDMS above the SU8 mastered lines and peeled
- Inspected wafer and peeled PDMS for evidence of resist delamination

PDMS Cross-section Imaging

- Each block of PDMS had a cross-section cut approximately 1 cm in length
- Cross-sections were placed sideways on top of a clean room sticky note (for contrast purposes) such that the cross-section of the molded channels could be visualized
- Images were taken of the focused views

Results

Pretreatment 1

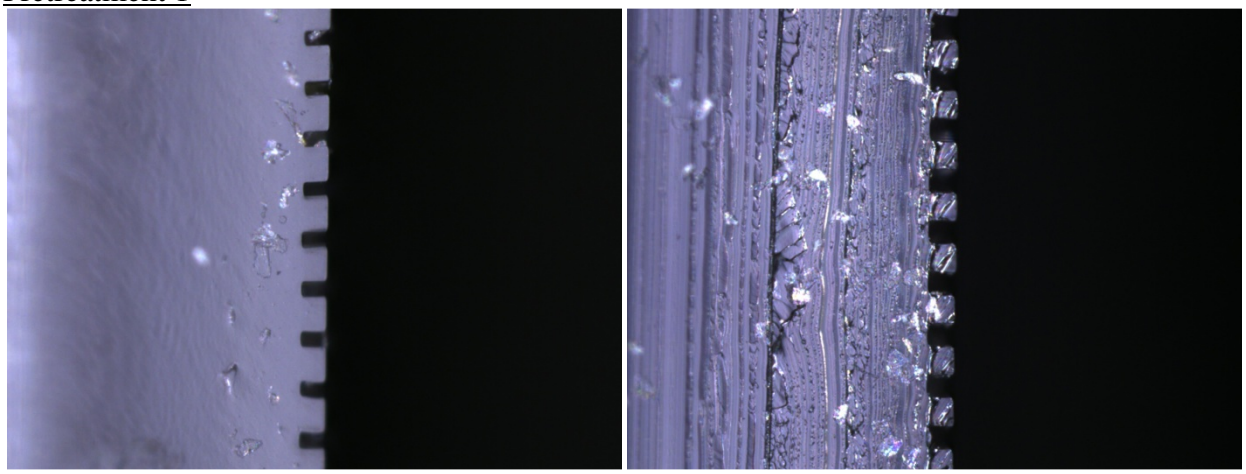

Figure 2: Cross-sectional images of PDMS casts of SU-8 masters fabricated with a BOE wash wafer pretreatment. At left is the image of the "10x50" channels and at right is the image of the "25x50" channels.

Pretreatment 2a

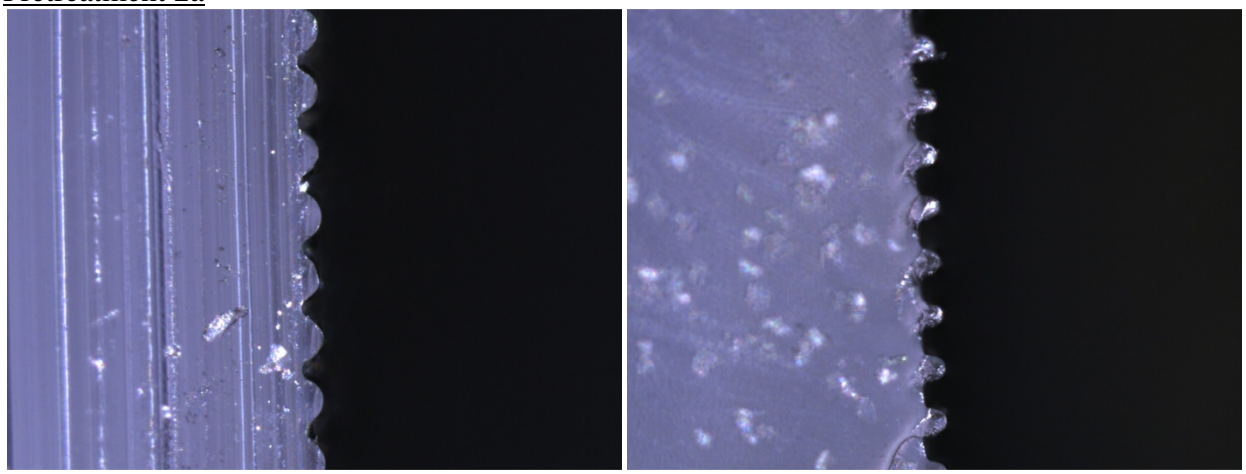

Figure 3: Cross-sectional images of PDMS casts of SU-8 masters fabricated with a 5 µm base layer of SU-8 without post-exposure bake as a wafer pretreatment. At left is the image of the "10x50" channels and at right is the image of the "25x50" channels.

Pretreatment 2b

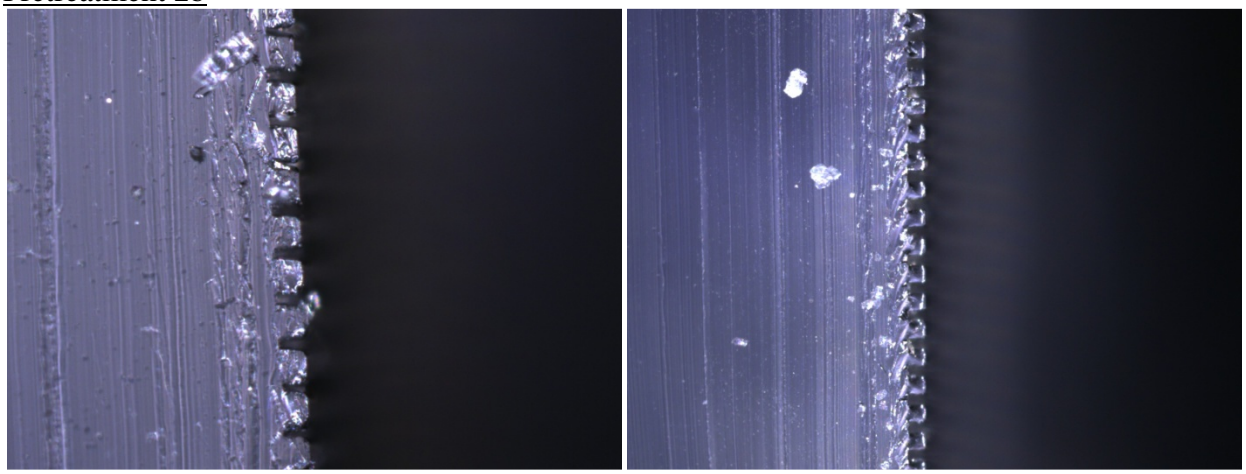

Figure 4: Cross-sectional images of PDMS casts of SU-8 masters fabricated with a 5 µm base layer of SU-8 with post-exposure bake as a wafer pretreatment. At left is the image of the "10x50" channels and at right is the iage of the "25x50" channels.