SU-8 Delamination Resistance Study Report

Steven Henry  
*University of Pennsylvania*

Eric Johnston  
*University of Pennsylvania*

Justin Wen  
*University of Pennsylvania, jwen@seas.upenn.edu*

Follow this and additional works at: [http://repository.upenn.edu/scn_protocols](http://repository.upenn.edu/scn_protocols)

[http://repository.upenn.edu/scn_protocols/6](http://repository.upenn.edu/scn_protocols/6)

This paper is posted at Scholarly Commons. [http://repository.upenn.edu/scn_protocols/6](http://repository.upenn.edu/scn_protocols/6)

For more information, please contact repository@pobox.upenn.edu.
SU-8 Delamination Resistance Study Report

Keywords
SU-8, Delamination, Microfluidics

Creative Commons License
This work is licensed under a Creative Commons Attribution 4.0 License.

This technical report is available at ScholarlyCommons: http://repository.upenn.edu/scn_protocols/6
SU-8 Delamination Resistance Study Report

Updated on 06/10/2016

Critical Factors

- Best treatments to prevent SU-8 photoresist delamination during development and PDMS casting and peeling:
  - BOE + Dehydration
  - BOE + SRD (Spin Rinse Dryer) + Dehydration
  - SRD + YES Oven (HMDS Priming)
- Flood exposing a 5um base layer of SU-8 underneath the desired SU-8 feature layer prevents delamination

Table of Contents

a. Goal
b. Results
c. Materials
d. Equipment
e. Protocol

Goal

To test SU-8 resistance to delamination induced by PDMS casting and peeling under various wafer pretreatment conditions

Results

<table>
<thead>
<tr>
<th>Wafer Treatment</th>
<th>Result</th>
<th>Image</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Treatment</td>
<td>Delamination</td>
<td>No Image</td>
</tr>
<tr>
<td>5um SU-8 Base Layer</td>
<td>Pass</td>
<td>No Image</td>
</tr>
<tr>
<td>Piranha + SRD + YES</td>
<td>Partial Delamination</td>
<td>Figures 1 &amp; 2</td>
</tr>
<tr>
<td>Piranha + SRD + Dehydration</td>
<td>Delamination</td>
<td>Figure 3</td>
</tr>
<tr>
<td>BOE + SRD + YES</td>
<td>Partial Delamination</td>
<td>Figure 4</td>
</tr>
<tr>
<td>BOE + SRD + Dehydration</td>
<td>Pass</td>
<td>Figure 5</td>
</tr>
<tr>
<td>BOE + YES</td>
<td>Delamination</td>
<td>Figures 7 &amp; 8</td>
</tr>
<tr>
<td>BOE + Dehydration</td>
<td>Pass</td>
<td>Figures 9 &amp; 10</td>
</tr>
<tr>
<td>SRD + YES</td>
<td>Pass</td>
<td>Figure 6</td>
</tr>
<tr>
<td>Surpass + IPA</td>
<td>Delamination</td>
<td>Figures 11 &amp; 12</td>
</tr>
<tr>
<td>Acetone + IPA + Dehydration</td>
<td>Delamination</td>
<td>No Image</td>
</tr>
<tr>
<td>MCC 80/20</td>
<td>Partial Delamination</td>
<td>No Image</td>
</tr>
</tbody>
</table>
Figure 1: Piranha + SRD + YES treated wafer, 10um x 20um features and 40um height, 40x zoom.

Figure 2: Partial delamination of Piranha + SRD + YES treated wafer, with 10um x 20um features and 40um height.

Figure 3: Partial delamination of BOE + SRD + YES treated wafer, with 10um x 15um features and 40um height, 20x zoom.

Figure 4: Delamination of Piranha + SRD + Dehydration treated wafer with 10x30um and 10x20um features and 40um height.

Figure 5: SRD + YES Oven treated wafer with 30x50um features and 40um height.

Figure 6: BOE + SRD + Dehydration treated wafer with 10x30um and 10x20um features and 40um height.
Figure 7: Delamination of BOE + YES oven treated wafer with 10x15um and 10x20um features and 40um height.

Figure 8: Partial delamination of BOE + YES oven treated wafer with 30x50um features and 40um height.

Figure 9: BOE + Dehydration treated wafer with 10x15um and 10x20um features and 40um height.

Figure 10: BOE + Dehydration treated wafer with 30x50um features and 40um height.

Figure 11: Delamination of Surpass + IPA treated wafer with 10x15um and 10x20um features and 40um height.

Figure 12: Delamination of Surpass + IPA treated wafer with 30x50um features and 40um height.
Materials

- SU-8 2005 (produced by thinning SU-8 2050)
- SU-8 2010 (produced by thinning SU-8 2050)
- SU-8 2025 (produced by thinning SU-8 2050)
- SU-8 thinner
- 3 inch diameter silicon wafers
- 4 inch diameter silicon wafers
- Line photomask (transparency film)
- Isopropyl alcohol (IPA)
- Acetone
- MCC 80/20
- Buffered oxide etchant (BOE) in HF hood
- Surpass
- PDMS/PDMS Curing Agent

Equipment

- Laurell spinner
- Hotplate
- YES Oven
- Spin Rinse Dryer (SRD)
- ABM mask aligner
- Vacuum Chamber

Protocol

a. Preparation of SU-8 2005/2010/2025 equivalent from SU-8 2050 stock

1. Weigh out SU8-2050
2. Calculate weight of thinner to add via:
   a. \( W_{\text{thinner}} = \left( \frac{\% \text{ solids initial}}{\% \text{ solids final}} - 1 \right) W_{\text{resist}} \)
3. Mix with glass stirring rod in beaker for ~ 10 min until homogeneous
4. Aliquot using Teflon funnel into resist bottles
5. Allow bottles to degas by resting at room temperature overnight
6. Long-term storage of bottles in resist cabinet

b. Wafer pretreatments tested

1. No treatment (including dehydration)
2. Dehydration for at least 10 minutes at 200 °C
3. Acetone wash + IPA wash + nitrogen blow-dry + minimum 10 min dehydration 200 °C
4. 2 min BOE wash + 2 min rinse in overflow bath + nitrogen gun-dry + minimum 10 min dehydration 200 °C
5. Dehydration for at least 10 minutes at 200 °C + spinning and flood exposing a base layer of SU-8 of 5µm
6. Dehydration for at least 10 minutes at 200 °C + spinning a layer of MCC 80/20 primer (commercially available from MicroChem consisting of 20% HMDS and 80% PM Acetate)
c. MCC 80/20 spinning

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 MCC 80/20 primer to cover the entire wafer
4. Allowed the primer to sit for 10-15 seconds
5. Spun the wafer
6. Transferred spun wafer to 110 °C hot plate for 2 min bake

b. Resist exposure and development

1. Start the ABM UV lamp (channel A). After suitable warm-up period, measured bulb exposure power:
   a. Using power meter set to channel A, measure power through transparency, glass blank, and Omega Optical filter: 14.2 mW/cm²
   b. Compute required exposure time: 155 mJ/cm² / 14.2 mW/cm² = 10.9 sec
2. Mount wafer, photomask and filter
3. Contact to glass blank with leveling
4. Post-exposure bake:
   a. 1 min at 65 °C
   b. 5 min at 95 °C
5. Develop in bath of SU-8 developer for 5-10 min with periodic agitation
6. Rinse with IPA and acetone and nitrogen blow-dry

d. PDMS Casting and Peeling

1. Placed wafers in aluminum foil dishes of appropriate depth
2. Mixed ~ 50 g of PDMS at 10:1 base:cure by weight ratio per wafer and degassed under vacuum until clear (~ 45 min)
3. Poured PDMS to a depth of 7 mm over each wafer on a level aluminum block
4. Transferred block to preheated 100 °C convection oven
5. Cured PDMS for 70 min
6. Allowed wafers to cool to RT
7. Using a new razor blade manually excised PDMS above the SU8 mastered lines and peeled
8. Inspected wafer and peeled PDMS for evidence of resist delamination
Table 1: 02/10/2014 results of delamination study performed on 1/31/2014 SU8 masters. Study was conducted by casting 10:1 (base:cure by weight) PDMS slabs to a depth of 7 mm and curing at 100 C for 70 min. After wafers cooled to RT, PDMS slabs were manually peeled from the master. Post-peel masters were inspected under an optical microscope for evidence of SU8 delamination. Out of all conditions tested, the BOE pre-treated wafer was the most robust in withstanding PDMS casting.

*Delamination likely due to edge bead and not wafer pretreatment at this location.

<table>
<thead>
<tr>
<th>Wafer Treatment</th>
<th>Plateau Length</th>
<th>Trough Length</th>
<th>Exposure Length</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>um</td>
<td>um</td>
<td>8.9 s</td>
</tr>
<tr>
<td>No Treatment</td>
<td>25</td>
<td>50</td>
<td>Delamination</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>50</td>
<td>Delamination</td>
</tr>
<tr>
<td>Dehydration</td>
<td>25</td>
<td>50</td>
<td>Delamination</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>50</td>
<td>Delamination</td>
</tr>
<tr>
<td>Acetone+IPA+Dehydration</td>
<td>25</td>
<td>50</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>50</td>
<td>Delamination</td>
</tr>
<tr>
<td>BOE + Dehydration</td>
<td>25</td>
<td>50</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>50</td>
<td>Delamination</td>
</tr>
</tbody>
</table>

Table 2: Results of delamination study performed on 4/4/2015 and 4/26/2015 SU8 masters. Study was conducted by casting 10:1 (base:cure by weight) PDMS slabs to a depth of 7 mm and curing at 100 C for 70 min. After wafers cooled to RT, PDMS slabs were manually peeled from the master. Post-peel masters were inspected under an optical microscope for evidence of SU8 delamination.

<table>
<thead>
<tr>
<th>Base Layer Thickness</th>
<th>Plateau Length</th>
<th>Trough Length</th>
<th>Delamination Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 µm</td>
<td>25</td>
<td>50</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>50</td>
<td>Pass</td>
</tr>
<tr>
<td>10 µm</td>
<td>25</td>
<td>50</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>50</td>
<td>Pass</td>
</tr>
<tr>
<td>27 µm</td>
<td>25</td>
<td>50</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>50</td>
<td>Pass</td>
</tr>
<tr>
<td>Pretreatment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MCC 80/20</td>
<td>25</td>
<td>50</td>
<td>Partial Delamination</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>50</td>
<td>Partial Delamination</td>
</tr>
</tbody>
</table>