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KMPR Delamination Resistance Study Report

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Critical Factors

- No silicon wafer pretreatments were required to minimize KMPR photoresist delamination during PDMS casting and peeling for feature sizes on the order of 10 um or larger
- Proper exposure time is also necessary to minimize delamination
    - See ABM Operating Procedure binder for updated lamp power output through glass, 365nm filter, and polyfilm material.
- Resistance to delamination was achieved at sub-optimal exposure dosage when the wafer was pretreated by BOE rinse followed by dehydration.

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Goal

Test KMPR resistance to delamination induced by PDMS casting and peeling under various wafer pretreatment conditions.

Materials

- KMPR-1025 (produced by thinning KMPR-1050)
- SU8 thinner
- 4 inch diameter silicon wafers
- Line photomask (transparency film)
    - 10 um lines, 50 um troughs (“10X50”)
    - 25 um lines, 50 um 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.**

Equipment

- Laurell spinner
- Two hotplates
- ABM mask aligner

Protocol

Preparation of KMPR-1025 equivalent from KMPR-1050 stock

1. Weighed out 135.4 g KMPR1050
2. Calculated weight of thinner to add via:
    a. Wthinner = [(% solids initial /% solids final) – 1]*Wresist
    b. Wthinner = [(67.3/63.8) – 1]*135.4 g = 7.4 g thinner
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. Stored bottles in -20C freezer for long term storage. Before master generation, allowed bottles to warm to RT overnight.

Wafer pretreatments tested:

1. No treatment (including dehydration)
2. Dehydration for at least 10 minutes at 200C
3. Acetone wash + IPA wash + nitrogen blow-dry + minimum 10 min dehydration 200C
4. 2 min BOE wash+ 2 min rinse in overflow bath + nitrogen blow-dry + minimum 10 min dehydration 200C

KMPR spinning

1. Set spin parameters:
    a. Vacuum = “req”
    b. Step 1 of 2: 500 rpm, accel = “100”, 30 sec
    c. Setp 2 of 2: 3000 rpm, accel = “500”, 30 sec
        i. F40 Filmetrics measurement indicates these settings result in an approximately 20 um thick layer of resist
2. Mounted wafer and ensure centered
3. Poured photoresist without air entrapment to ~ 50 mm diameter
4. Spun the wafer
5. Transferred spun wafer to 95C hot plate for 10 min soft bake
6. If performing multiple spins, wiped spinner hood between wafers to prevent excess KMPR from dripping onto samples

Resist exposure and development

1. Started the ABM UV lamp (channel A). After suitable warmup period, measured bulb exposure power:
   a. Using power meter set to channel A, measured power through transparency material, glass blank, and Omega Optical filter: 13.9 mW/cm^2
   b. Computed required exposure time:572.5 mJ/cm^2 / 13.9 mW/cm^2 = 41.2 sec
2. Mounted wafer, transparency, aluminum foil aperture to block exposure of extraneous regions
3. Contacted to glass blank with leveling
4. Rested Omega Optical filter on top of glass blank
5. Exposed lines for 31.2 sec, 41.2 sec, and 51.2 sec respectively
6. Post-exposure bake 95C for 2 min
7. Developed in bath of SU-8 developer for 5-10 min with periodic agitation
8. Rinsed in IPA and nitrogen blow-dry

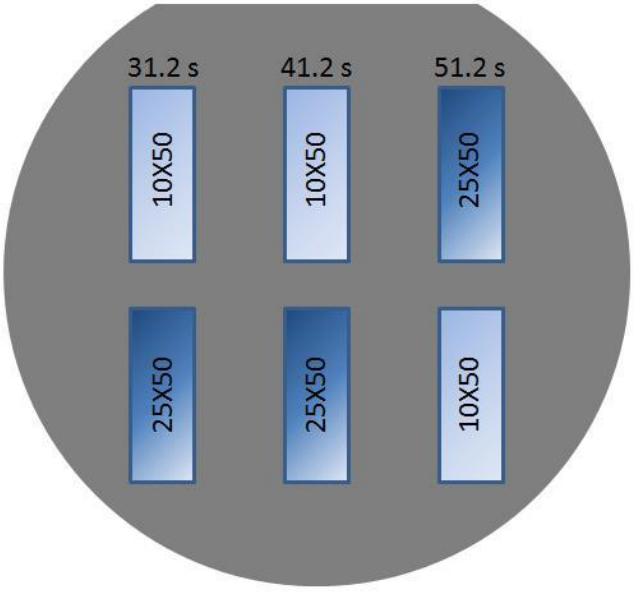

Figure 1. Schematic of wafer exposure series. Duration of exposure (Channel A) is indicated above each column. "10X50" = 10 um lines separated by 50 um troughs. "25X50" = 25 um lines separated by 50 um troughs. Aluminum foil apertures were made to restrict the exposure to the desired region of the wafer.

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 100C convection oven
- Cured PDMS for 70 min
- Allowed wafers to cool to RT
- Using a new razor blade manually excised PDMS above the KMPR mastered lines and peeled
- Inspected wafer and peeled PDMS for evidence of resist delamination

Results

	Plateau Length	Trough Length	Exposure Length		
Wafer Treatment	um	um	31.2 s	41.2 s	51.2 s
No Treatment	25	50	Pass	Pass	Pass
	10	50	Delamination	Pass	Pass
Dehydration	25	50	Pass	Pass	Pass
	10	50	Delamination	Pass	Pass
Acetone+IPA+Dehydration	25	50	Pass	Pass	Pass
	10	50	Delamination	Pass	Pass
BOE + Dehydration	25	50	Pass	Pass	Pass
	10	50	Pass	Pass	Pass

Table 1. 01/17/2014 results of delamination study performed on 12/06/2013 KMPR masters. Study was conducted by casting 10:1 (base:cure by weight) PDMS slabs to a depth of 7 mm and curing at 100 deg 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 KMPR delamination. Out of all conditions tested,the BOE pre-treated wafer was the most robust in withstanding PDMS casting.