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Effect of Post-Development Bake on Adhesion of SU-8

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Abstract
To test adhesion of under-exposed SU-8 structures with the wafer surface by Post-Development (PD) Bake.

SU-8 Post-Development Bake (Hard Bake) Study

Updated on 14 July 2017

Critical Factors

The post-development bake (hard bake or annealing step) at 150°C for 30 minutes is observed to improve adhesion of the under-exposed SU-8 structures with 2:1 aspect ratio.

A post-development step can also ensure that SU-8 2000 properties do not change in actual use. SU-8 2000 is a thermal resin and as such its properties can continue to change when exposed to a higher temperature than previously encountered.

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Goal

To test adhesion of under-exposed SU-8 to silicon substrate by post-development (PD) bake.

Results

Wafer Treatment	Result	Comments	Image
No treatment	The structures are not well adhered	Induced under exposure resulted in poor adhesion	Fig: 1, 3, 9, 11, 7, 5
No PD bake treatment wafer subjected to PDMS testing	The channels are peeled off along with PDMS	Weak adhesion resulted in channel peel off	Fig: 2, 4
5 min PD bake at 150°C	No significant change in the adhesion	The baking time of 5min is not sufficient to improve adhesion	Fig: 6, 8
30 min PD bake 150° C	The adhesion is improved	The absence of interference fringes at the edges means improved adhesion	Fig: 10, 12
30 min PD bake 150° C followed by PDMS testing	The structures remain intact after testing with PDMS	This shows improved adhesion due to bake	Fig: 14, 16

**To get reliable results, images of the same areas on the wafer are compared before and after treatment*

No PD bake followed by PDMS peel test

Before PDMS Peel Test

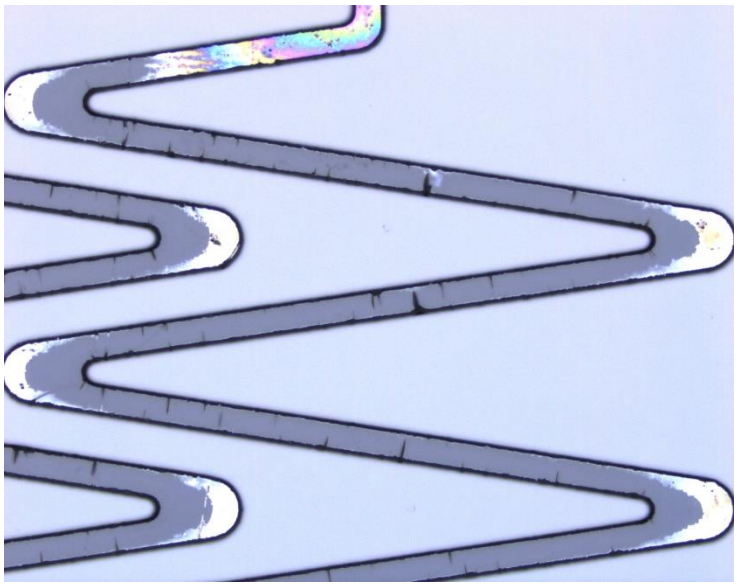

Figure 1 Under-exposed wafer prior to PD bake

After PDMS Peel Test

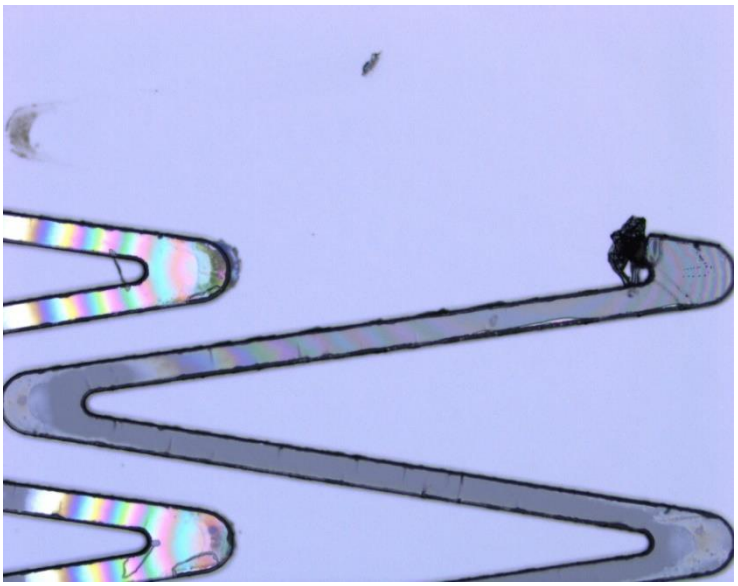

Figure 2 Delamination after PDMS peel test

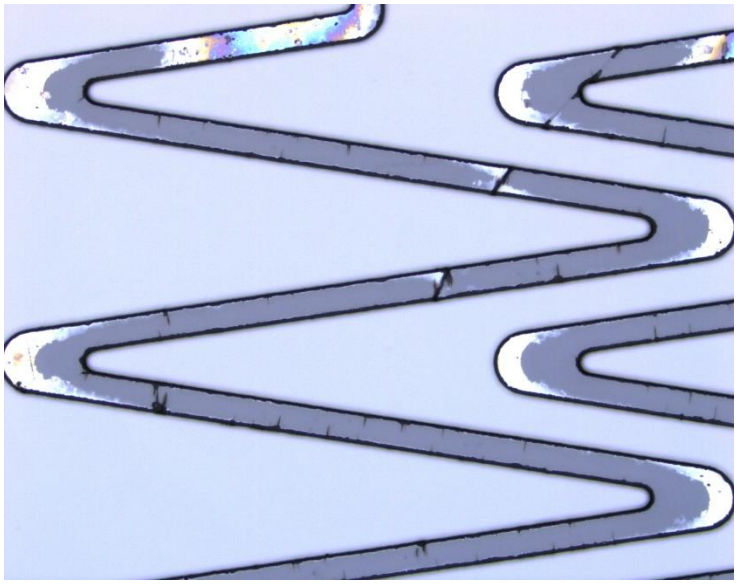

Figure 3 Under-exposed wafer prior to PD bake

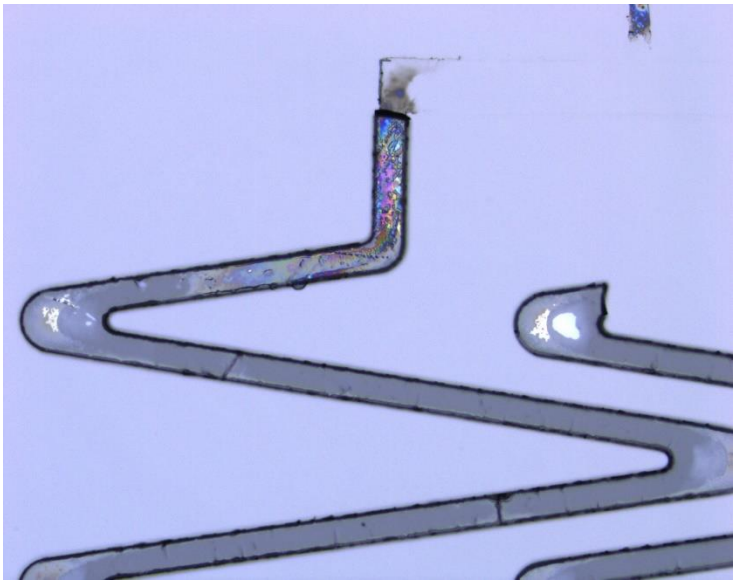

Figure 4 Delamination after PDMS peel test

5 min PD bake at 150ºC

Before Bake

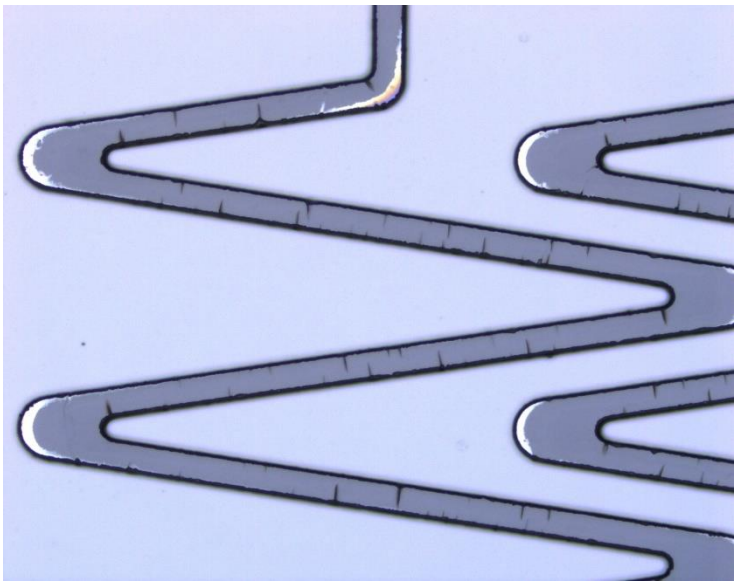

Figure 5 Under-exposed wafer prior to PD bake

After Bake

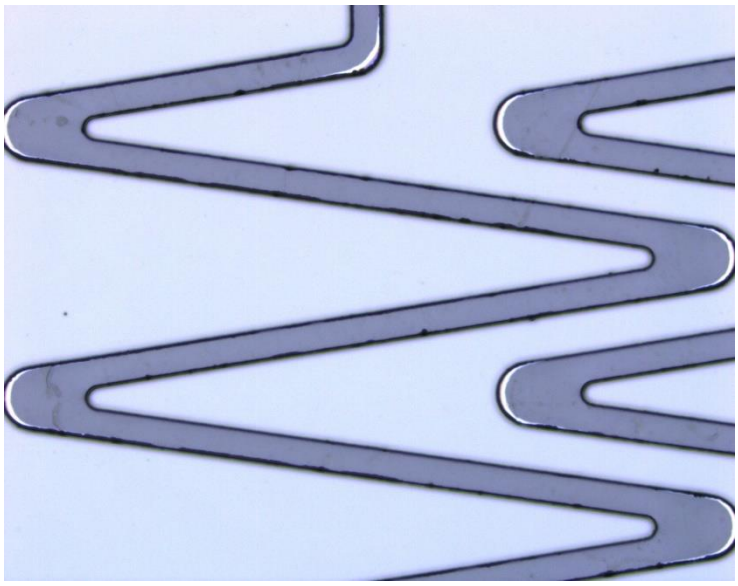

Figure 6 Insufficient time resulted in minor healing of interference fringes

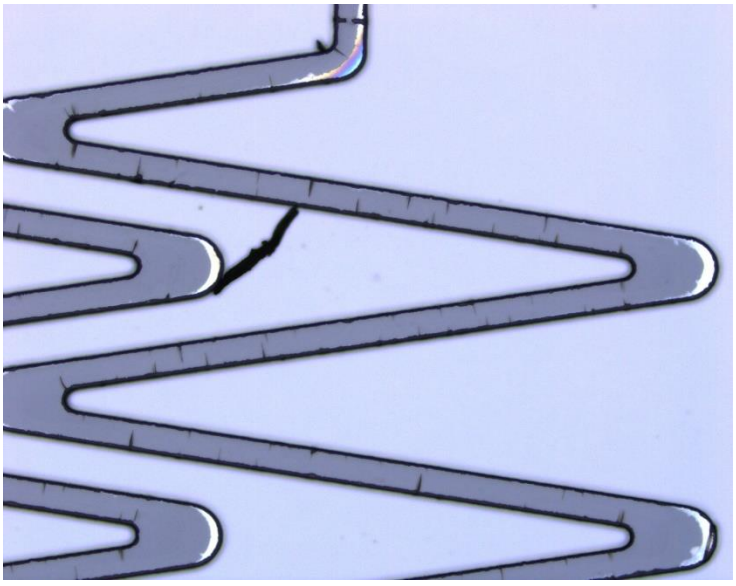

Figure 7 Under-exposed wafer prior to PD bake

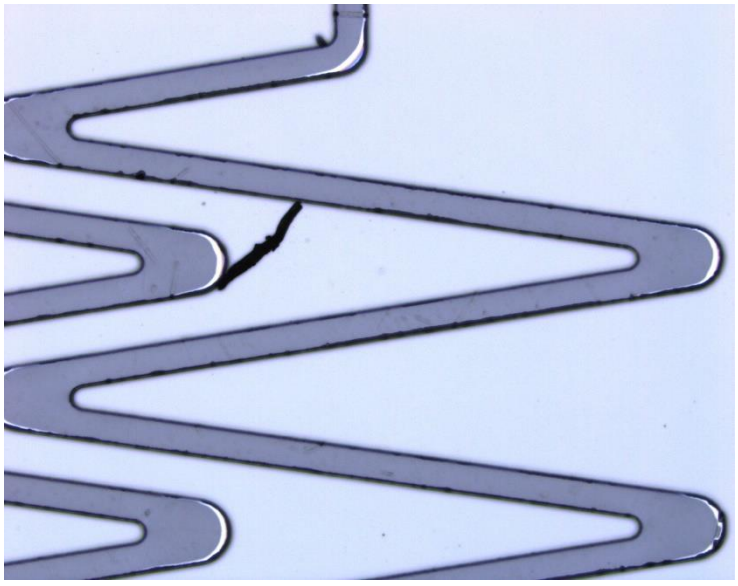

Figure8 Insufficient time resulted in minor healing of interference fringes

30 min PD bake at 150ºC

Before Bake

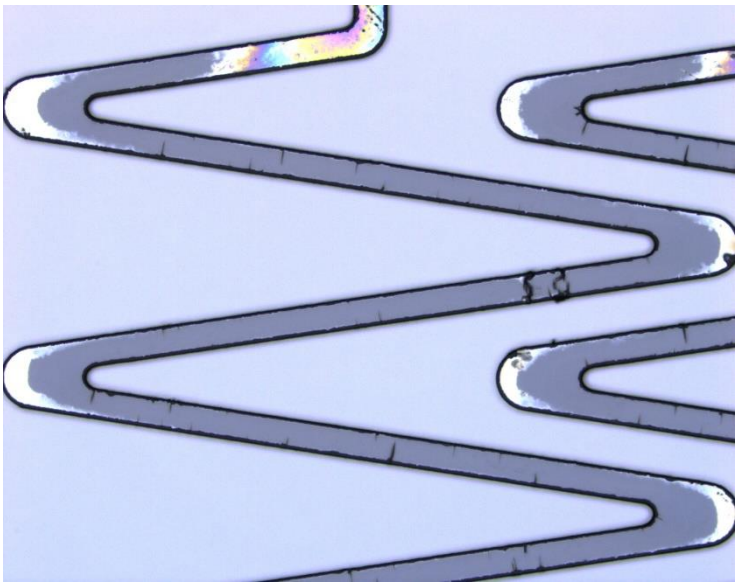

Figure 9 Under-exposed wafer prior to PD bake

After Bake

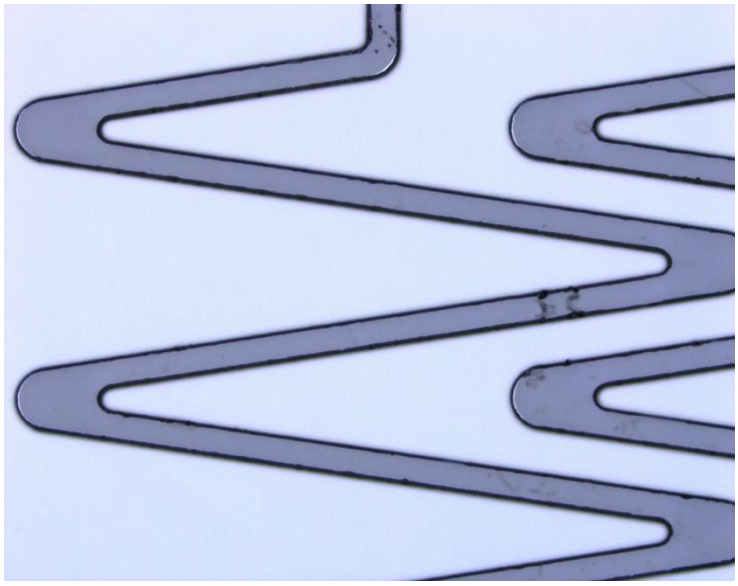

Figure 10 Interference fringes showing areas of weak adhesion vanished after PD bake

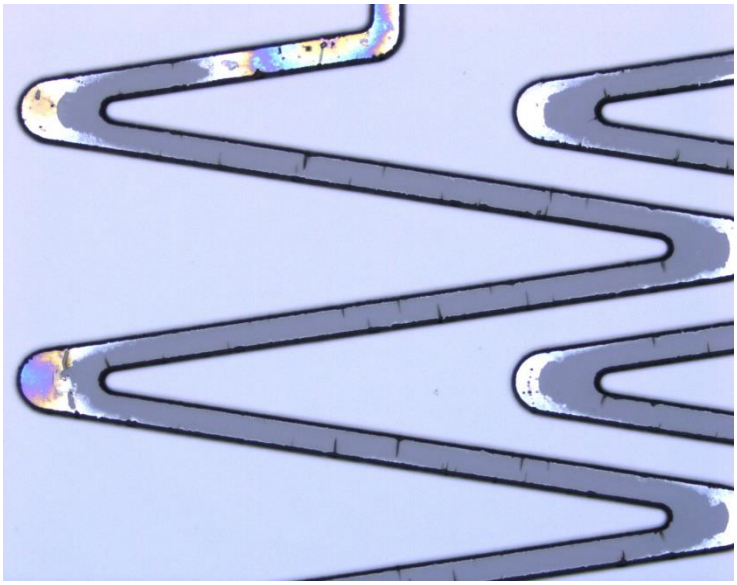

Figure 11 Under-exposed wafer prior to PD bake

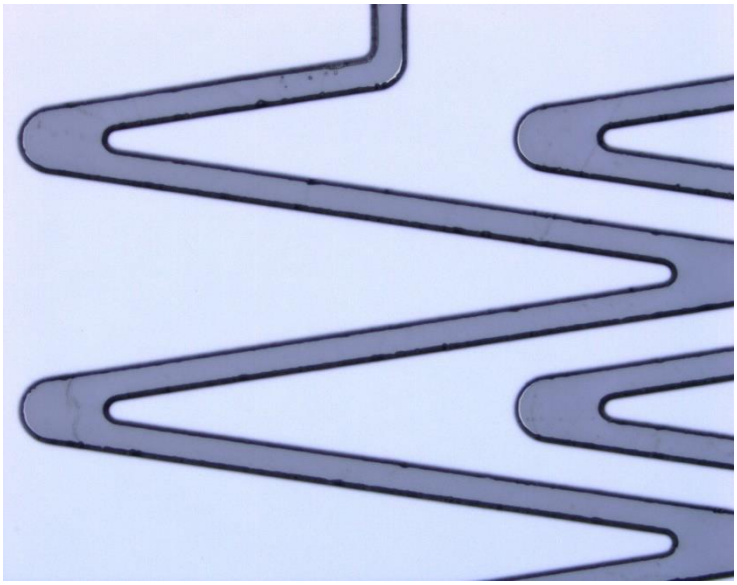

Figure 12 Interference fringes showing areas of weak adhesion vanished after PD bake

30 min PD bake at 150° C followed by PDMS testing

After PD Bake

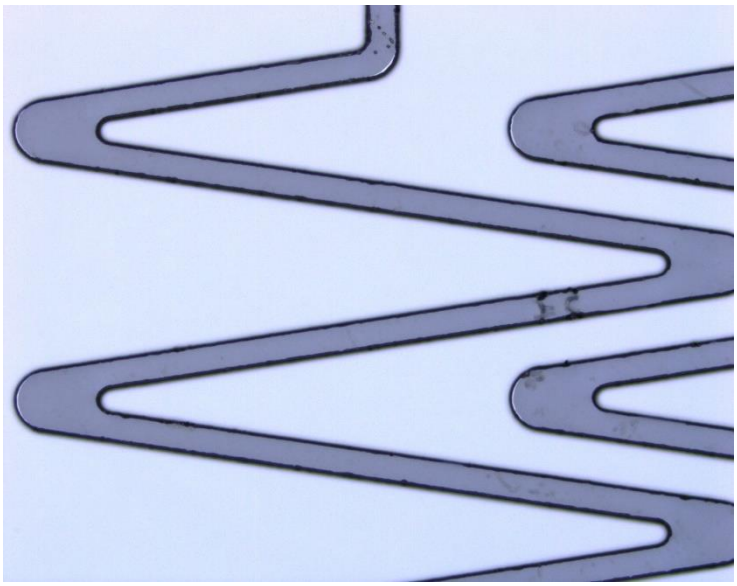

Figure 13 Channels after PD bake and before PDMS peel test

After PDMS Peel Test

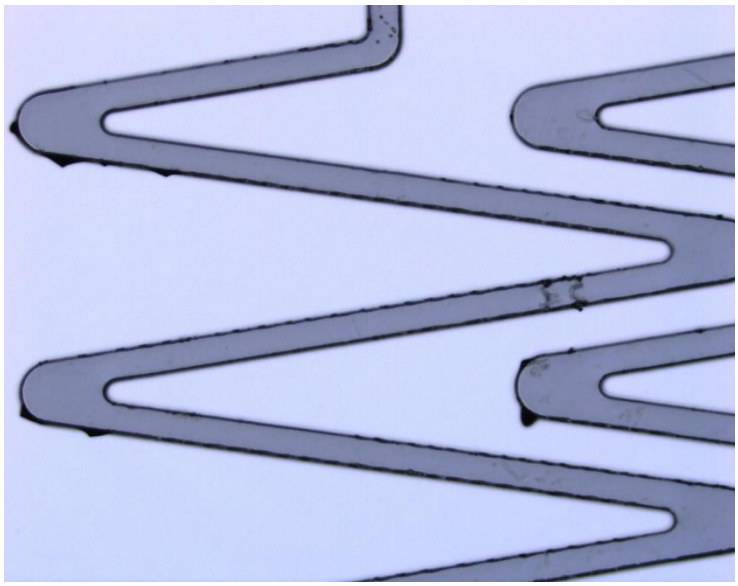

Figure 14 Channels do not delaminate after PDMS peel test

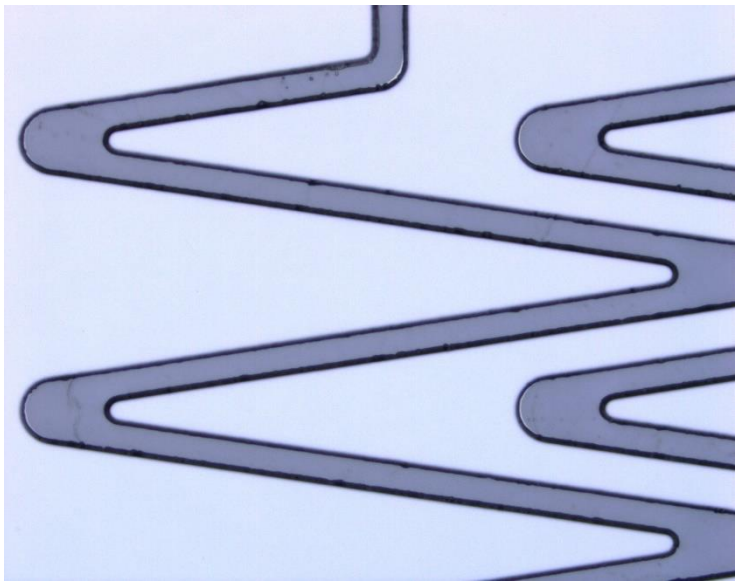

Figure 15 Channels after PD bake and before PDMS peel test

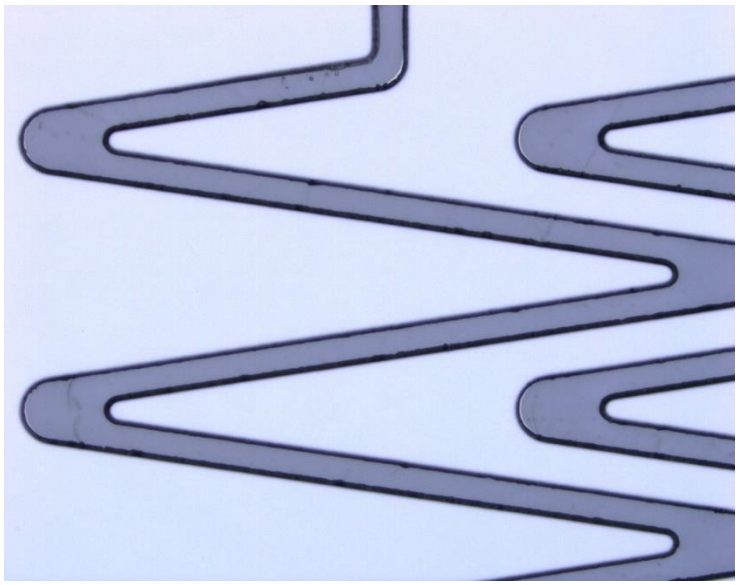

Figure 16 Channels do not delaminate after PDMS peel test

Materials

- SU-8 2050
- 3-inch diameter Silicon wafer
- Mask with features of width 70 Microns (transparency film)
- SU-8 Developer
- Isopropyl alcohol (IPA)
- PDMS
- PDMS curing agent

Equipment

- Laurell spinner
- Hotplate
- Vacuum chamber
- Oven
- ABM mask aligner
- Zeiss Axio Imager M2m at 5X optical zoom

Protocol

Experiment

- Plain wafer is baked for 15 minutes at 200 degrees
- 100 μm thickness layer is deposited by spin coating 2050 SU-8 at 1700RPM
- It is subjected to soft bake at 65 degrees for 5 min and 95 for 20 min
- After exposing the wafer at specific dose (230 mJ/cm^2) and time, it is subjected to post-exposure bake at 65 degrees for 5 min and 95 for 10 min
- The wafer is developed for 10 min in SU-8 developer, sprayed with IPA and blow dried with Nitrogen gun
- Optical images of fine features are captured

- The wafer is subjected to hard bake at 150 for 5, 30 minutes optical images of the same features are taken for comparison**.**
- PDMS is cured by below steps and is separated from the wafer to test the adhesion strength between the features and the wafer
- Optical images of the features are taken
- One part of the wafer with no post-development bake is subjected to PDMS adhesion test and optical images are again taken to compare them with treated wafer images

PDMS preparation:

- A 10:1 ratio by weight mixture of PDMS base and curing agent is prepared
- PDMS base-curing agent mixture is adequately mixed
- PDMS base-curing agent mixture is placed in degassing chamber for 15 min
- The mixture in poured on the wafer containing test feature and is cured at 80^{o}C for 20 minutes