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Releasing Polydimethylsiloxane (PDMS) Replica Parts From Micromolds

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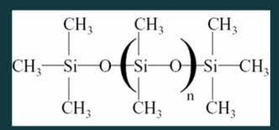
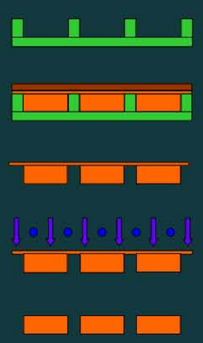
Properties of Polydimethylsixane (PDMS)

- Moldable
- Deformable
- Chemically inert
- Hydrophobic
- Transparent
- Insulating
- Microelectronics compatible



Process flow for releasing PDMS replica parts from micromolds



a. Create SU-8 micromold

b. Cast PDMS in the micromold. Planarize cast by applying force to a flat glass on top of mold

c. Release cured PDMS replica. A thin residual layer will hold parts together

d. Plasma etch to remove residual PDMS layer

e. Released PDMS replica parts

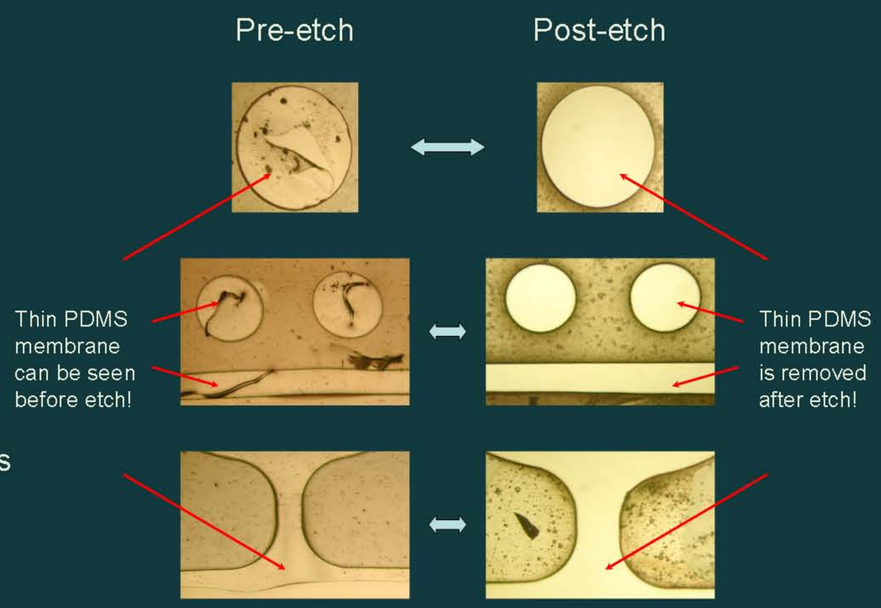
a. An SU-8 micromold is created on a Si wafer and silanized by exposure to the vapor of (Tridecafluoro-1,1,2,2-tetrahydrooctyl)-1-trichlorosilane) at -22 inHg and room temperature for 1 hour.

b. A mixture of PDMS pre-polymer and crosslinking agent (3:1 wt. ratio) is cast and cured (60 ℃ at 1 atm for 3 hrs) on the micromold. A five inch square glass plate is compressed with 15 lbs. of pressure on top of the cast prior to and during the curing.

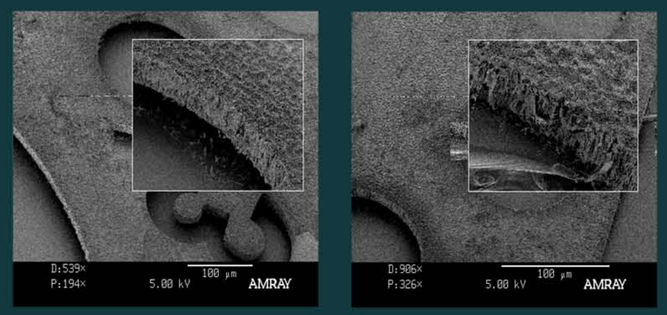
c. The PDMS replica is peeled out of the micromold, and the glass plate is removed. A thin (20 to 30 μm) residue layer remains on the top surface.

d. The residue layer is removed using Reactive ion etching (RIE).

e. The PDMS replica parts are released separately.

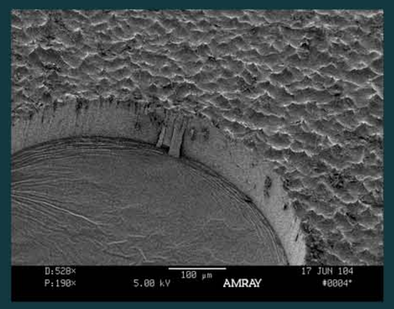


Comparison between different etch processes



SEM photomicrographs show O_2/CF_4 has better sidewall protection than He/SF_6!

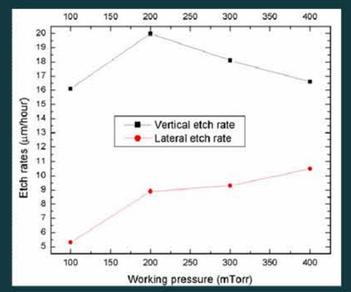
A close look at the sidewall with O_2/CF_4 as etchants



Gas (sccm)	RF Power (w)	Pressure (mtorr)	Etch Rate (μm/h)
He/SF_6 (80/60)	200	200	8
O_2/CF_4 (9/100)	300	200	20

O_2/CF_4 has faster etch rate than He/SF_6 !

Anisotropic etch of PDMS in O_2/CF_4 plasma



The vertical etch rate is approximately 3 times of the lateral etch rate!

Daniel Sang-Won Park *et. Al* *2004 , J. Micromech. Microeng*

Conclusion:

Individually released PDMS parts can be fabricated with a controlled thickness. After casting, a thin PDMS residual layer is left on top of the micromolds after casting, even when a glass plate is used to compress on top of the cast . Reactive ion etching (RIE) with He/SF_6 or O_2/CF_4 can be used to remove the PDMS residue layer and release PDMS replica parts perfectly. Plasma parameters, such as pressure, power, and the ratio of the mixed etchant gases, are optimized to achieve the fastest etching rate through experiments. The experimental results also proved that O_2/CF_4 has advantages over SF_6/He because it has *faster etch rate* and *better sidewall protection*.

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