

Fabrication and characterization of ultra-compliant substrates for bio-device integration

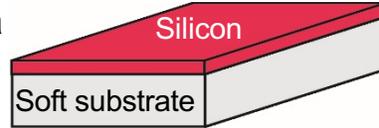
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Problem: A mismatch of ~8 orders of magnitudes exists between the elastic modulus of cells natural environment (soft) and device substrates (hard).

Long-term goal: Integrating cells and devices on a platform consisting of an ultra-thin device substrate bonded to a soft material.



Short-term goal: Fabrication of the optimum soft substrate to be integrated with ultra-thin device templates and biological cells.

Desired characteristics:

- 1) Elastic modulus in the range of 5-500 kPa;
- 2) Stable hydrophilic surface
- 3) Biocompatibility
- 4) High yield

Materials and Methods:

Material: Polydimethylsiloxane

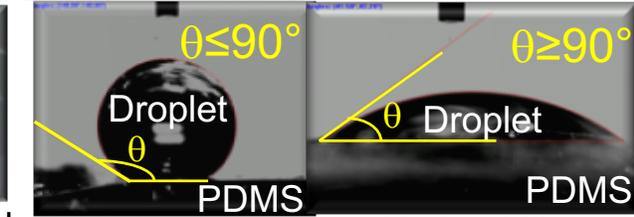


527 1:1 standard 184 10:1 standard

Fabrication:

- Mixing (base, curing agent)
- De-gassing
- Curing (temperature, time)
- Soxhlet
- Surface modification (UV Ozone)
- Handling

Characterization:

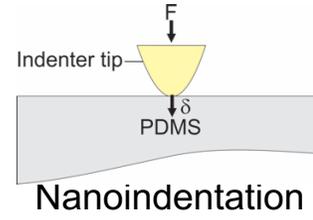


Hydrophobic surface

Hydrophilic surface



Tensile test



Nanoindentation via AFM

Results:

527 : 184 PDMS kits	Contact angle		Elastic modulus kPa	
	0 hr	24 hr	Global	Local
0:1 (0:0) : (50:1)	79.67°	71.78°	955 kPa	20.34 kPa
20:1 (1:1) : (10:1)	59.41°	55.25°	718 kPa	86.69 kPa
10:1 (2:1) : (9:1)	73.95°	65.25°	857 kPa	54.63 kPa
10:1 (3:1) : (9:1)	76.15°	41.97°	802 kPa	26.64 kPa

An improved handling method increased yield by ~45% - 50%.

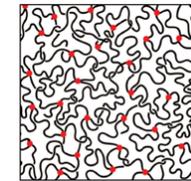
Maintaining substrates in DI water helped preserve their stable hydrophilic state for ~48-72 hr.

Conclusion:

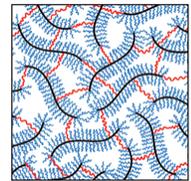
- Fabricated substrates with elastic modulus in the range of ~0.005-1.5 MPa and a stable hydrophilic surface over 3 days.
- Designed and fabricated a tension tester to measure elastic modulus.
- I increased the yield from ≥50% to ≤95% by improved the handling method for fabrication and characterization.

Future Directions:

- Explore PDMS with different mechanical structures, such as crosslinking bottle brush chains instead of loose cross linking chains.
- Explore different surface modification methods such as Piranha/ KOH which may keep substrate hydrophilic for 60 days.



Loose chains



Bottle brush

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