Cell Stretching

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Why stretch Cells

•Cells undergoing various kinds of strech in their lifetimes.

•Resting state is different from the « in stretch » state

•Cells adaprt when taken from resting to stretched state

•Once stretched for long its nomore stretched

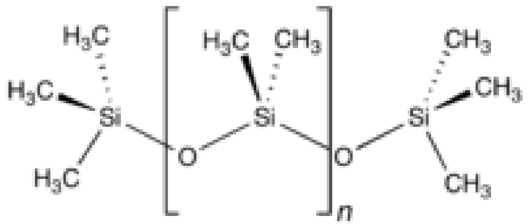
•Continuous cyclic stretch is a different configuration altogether

•Remodeled : Cell Orientation, actin cytoskeleton, signaling

•Strained state for the membrane. Understanding changes undergone and whats regulated.

The stretchable substrate

PDMS : Polydimethylsiloxane

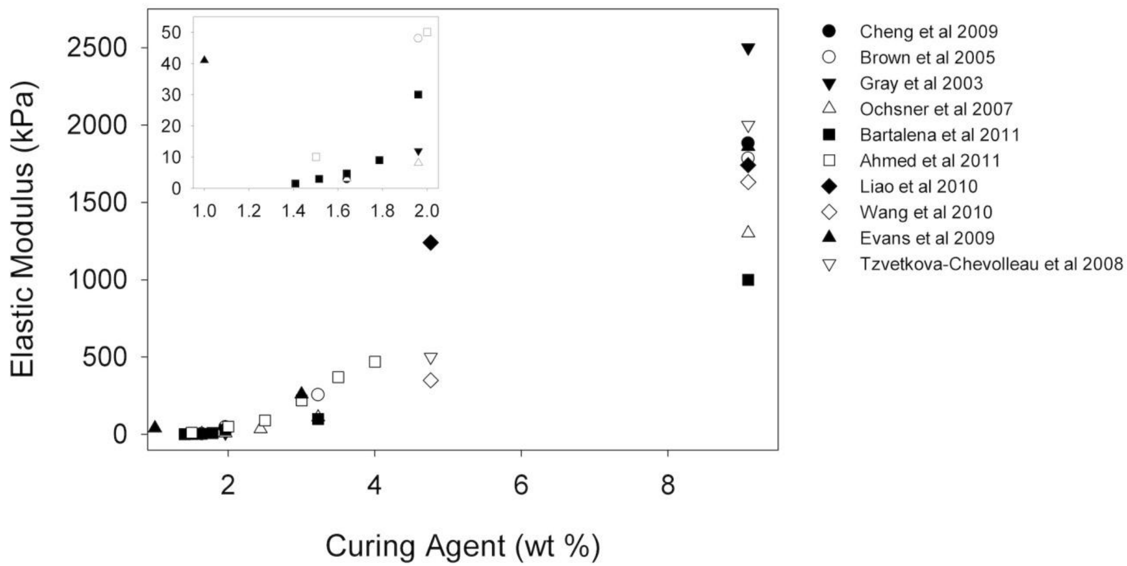


Prepolymer: Fluid/ viscous;
+crosslinking reaction : Elastic

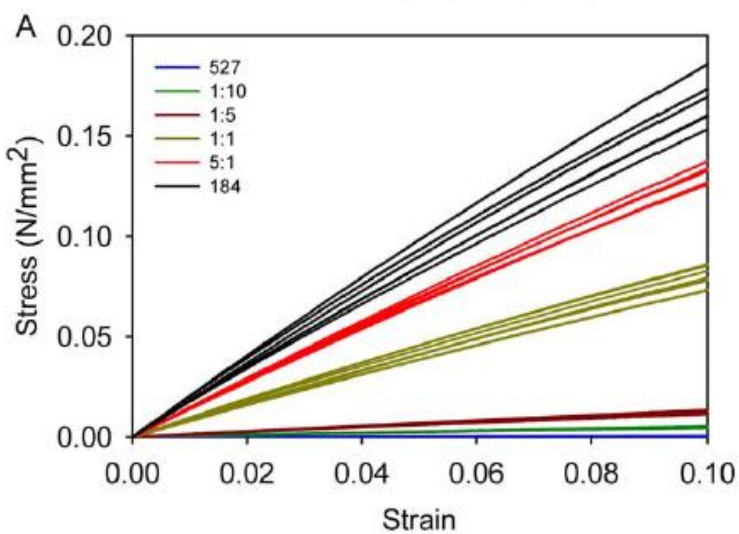
- Hydrophobicity : contact angle 90-120 degrees
- Refractive Index : ~ 1.4
- Surface Chemistry: tunable
- Stiffness: tunable

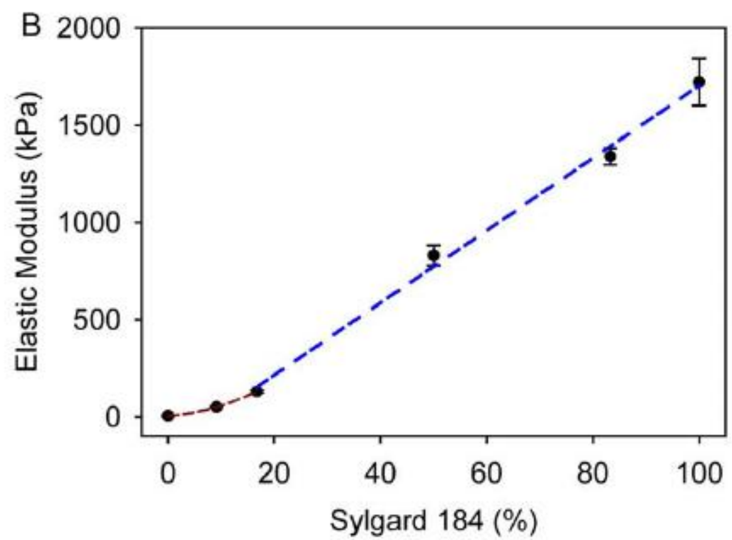
Other Polymers: h-PDMS, photocurable perfluoropolyethers (PFPE), cyclic olefin copolymer (a thermoplastic polymer), thermoset polyester, polymethylmethacrylate, polycarbonate, and polyurethanes

The Good



Mechanical Properties





Tensile Strength : 2.24 MPa

The Not-so-good

Optical Properties

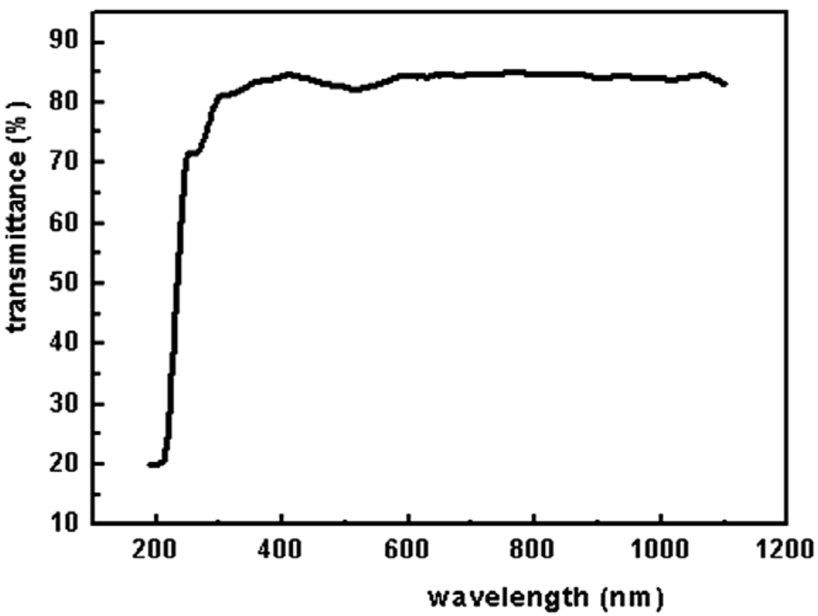


TABLE II
PDMS REFRACTIVE- INDEX CHANGES FOR VARYING CURING CONDITIONS

Sample	Curing Temperature (°C)	Curing Period	Refractive index 460nm	Refractive index 610nm
1	25 (RT)	48 hours	1.451	1.416
2	50	60 minutes	1.465	1.417
3	100	30 minutes	1.465	1.422
4	100	60 minutes	1.466	1.421
5	150	30 minutes	1.469	1.432
6	150	60 minutes	1.472	1.432

Microelectronic Engineering 83 (2006) 2499–2503

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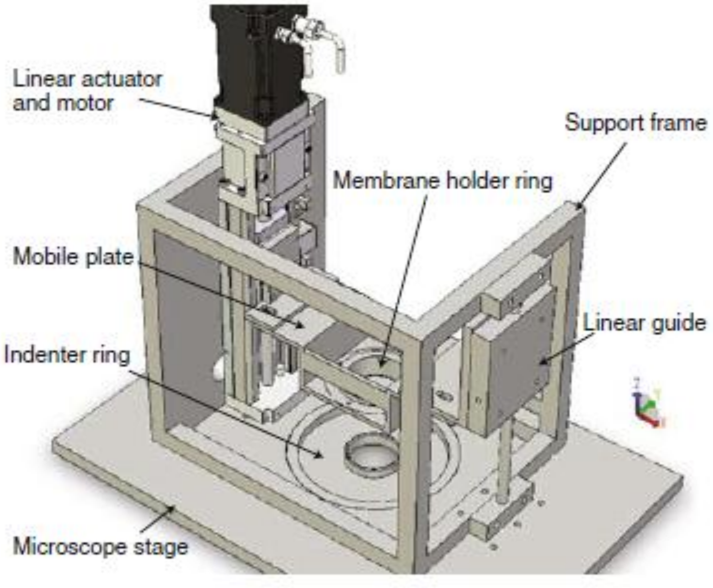
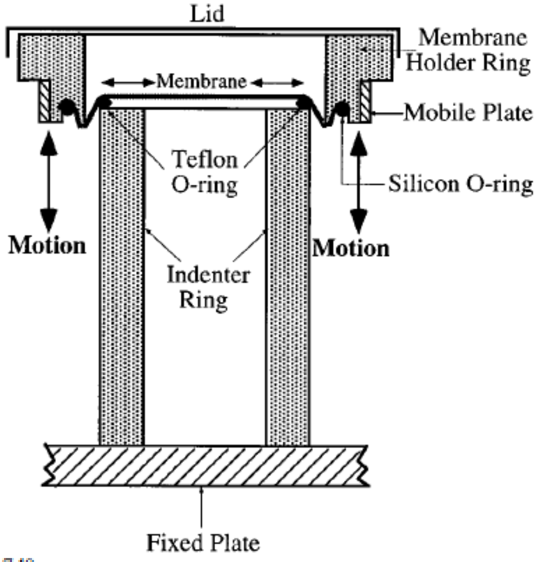
Various ways of stretching

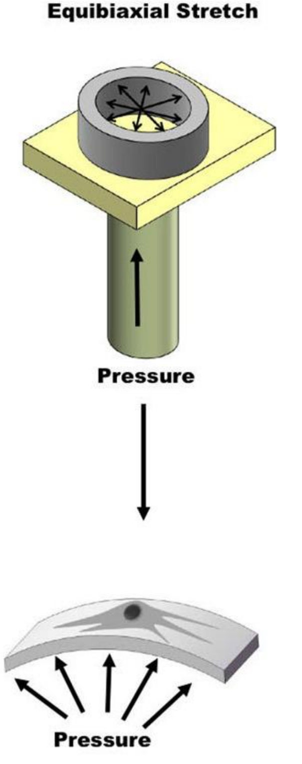
1. Uniaxial
2. Biaxial
3. Stretching by bending/swelling



Annals of Biomedical Engineering, Vol. 38, No. 5, May 2010 (© 2010) pp. 1728–1740

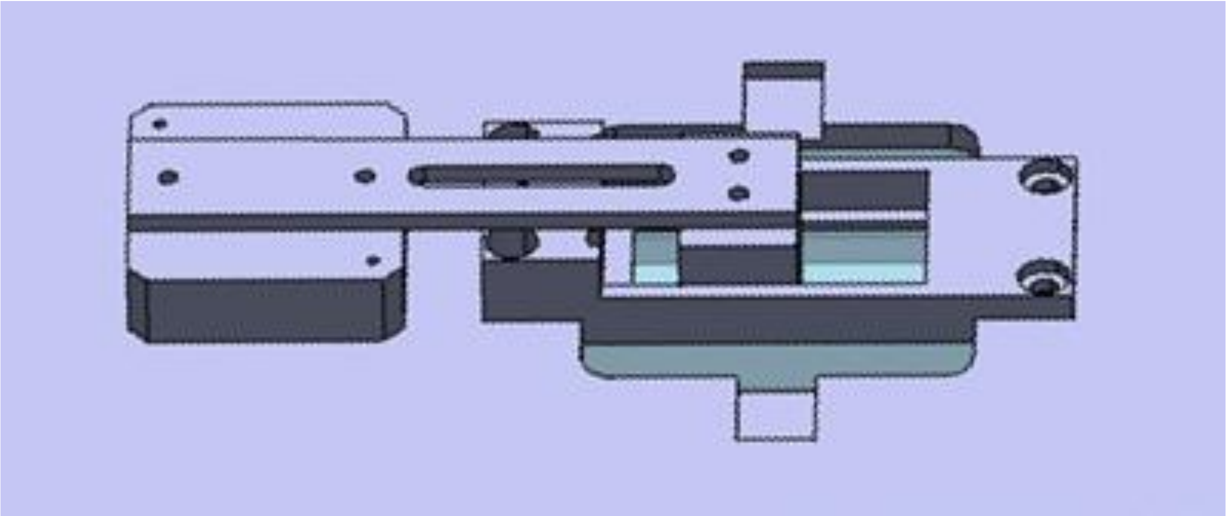


Annals of Biomedical Engineering, Vol. 26, pp. 181–189, 1998



Steward et al. *Scientific Reports (2011)*
Article number:147 doi:10.1038/srep00147

Our Stretcher



Key requirements:

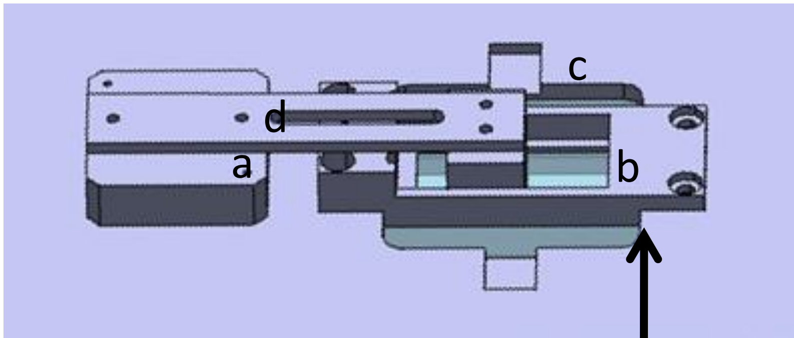
•Compatible with inverted microscopes, small working distance objectives

•Imaging live cells during stretch

•Modular, simple design where multiple samples can be loaded easily

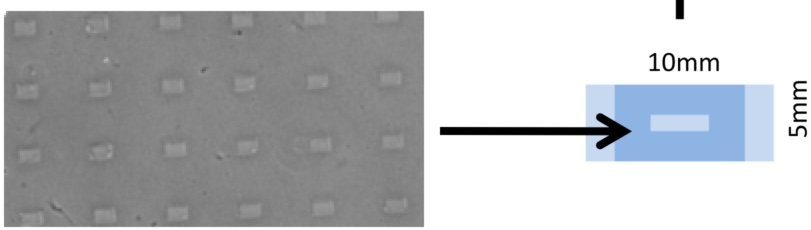
Stretching Device :-

A.



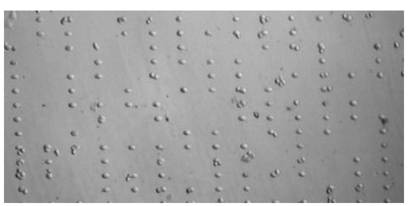
a. Linear actuator for pulling
b. Mount for PDMS sheet with cells
c. Resistors for temperature control
d. Coupler between actuator and movable part of the mount

B.



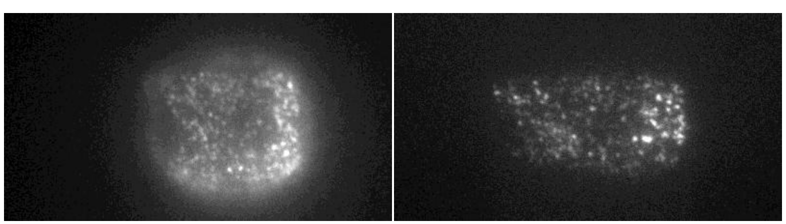
Micropatterned adhesive patches on PDMS for regulated cell shape and orientation

C.



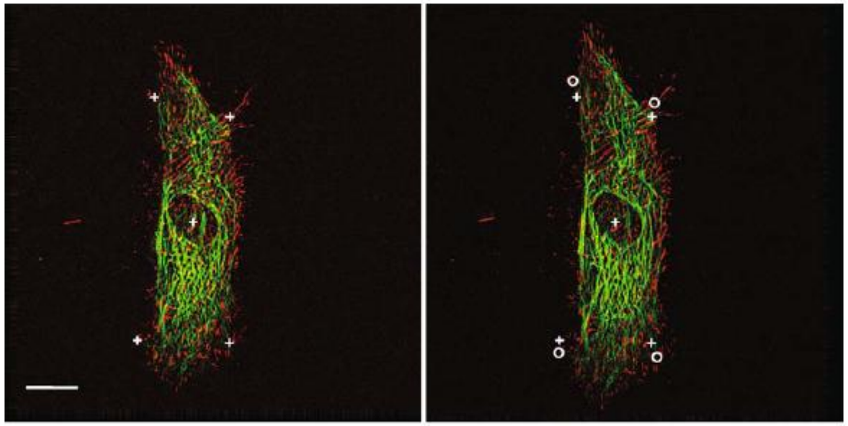
Plating cells on a pre-stretched mount

D.

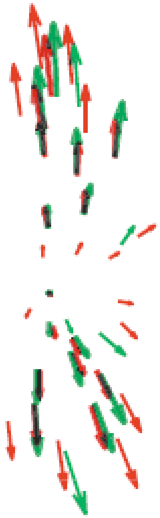


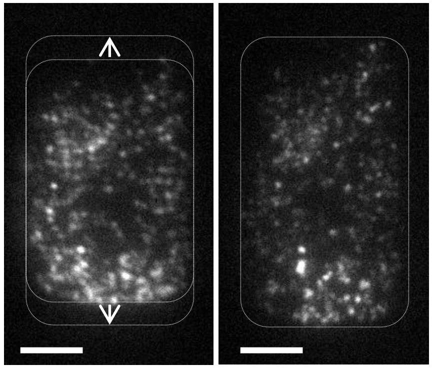
Imaging in TIRF and Stretching cells

Strain in your cell of interest



40×/0.75 NA



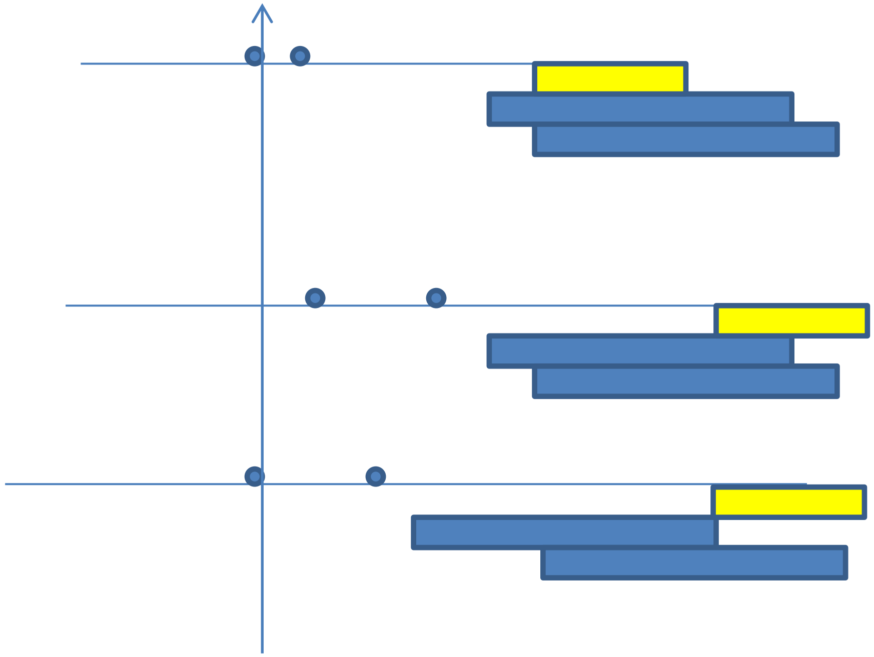


100x 1.45 NA

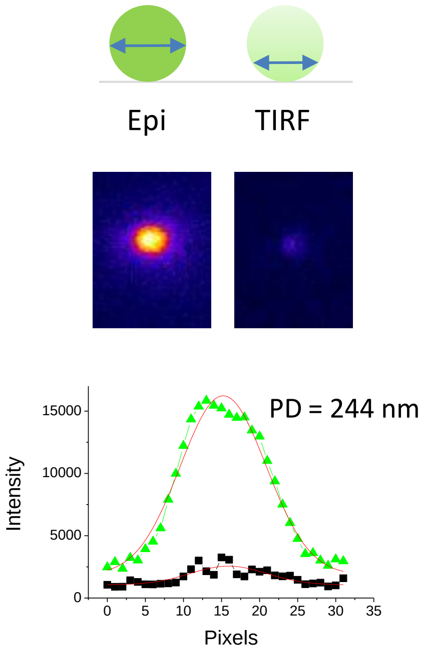
Micropattern to stop cell reorientation

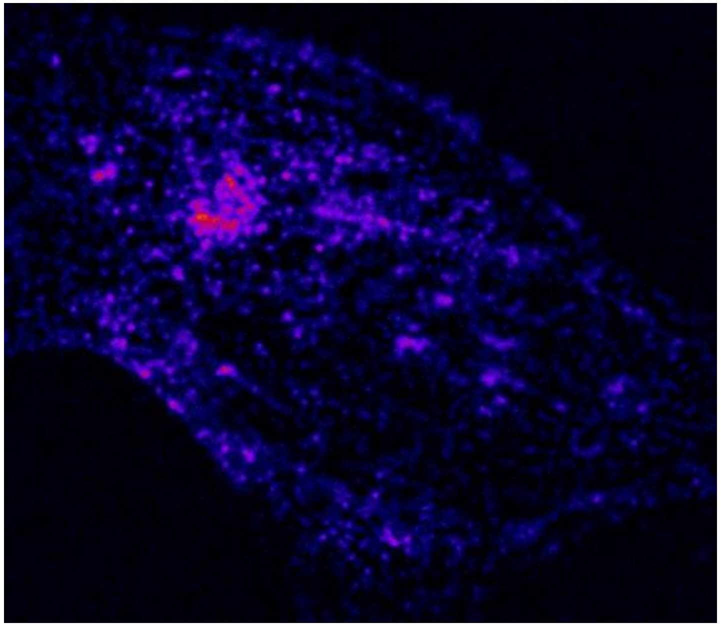
Continuous imaging while stretching

movie



Total Internal Reflection Fluorescence M





To burst or not

RBC that burst