Measuring Strain-dependent Surface Stress in Soft Matter

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Definitions and Motivations

Surface Stress: The amount of work per unit area needed to stretch a material (elastically).

Strain: $\epsilon = \frac{\Delta l}{l_0}$

Gels: Liquids exhibit strain-independent surface tension. Gels are comprised mostly of liquid, so it has been assumed that gels behaved similarly.

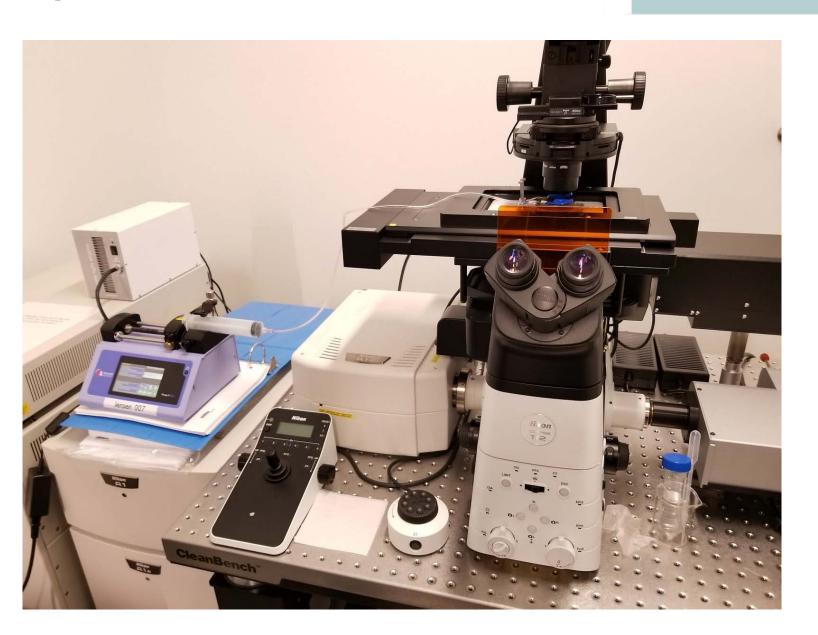
2017 Measurement: A 2017 paper (Qin, Jensen, et al. *Nat Comm* 2017) used contact angles to measure strain-dependent surface stress in soft matter.

Fluorescent Confocal Microscopy Silica Microsphere's diameter ~ 30 microns \$80 Microns

The silicone substrate, coated with fluorescent beads on the top and bottom surface. The silica microsphere sits on the top surface, indenting depth d in the substrate.

Indentation depth, d, is measured vs radius, r, of the silica microsphere

particle



Confocal
Microscope with
custom stage
insert and syringe
pump

Fluorescent

bead's

diameter ~

40nm

VAPOR

GEL

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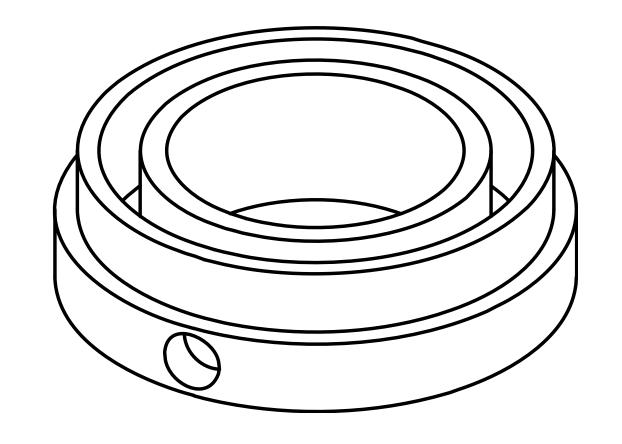
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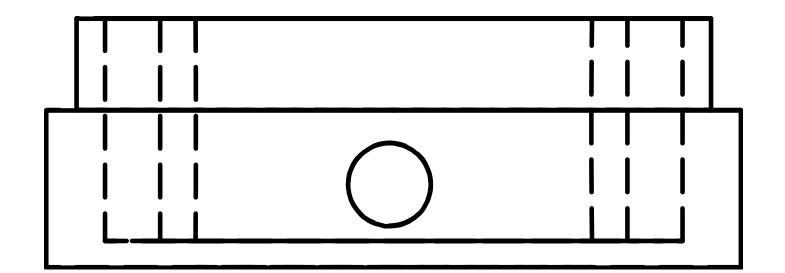
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Homogeneous Equi-biaxial Stretching

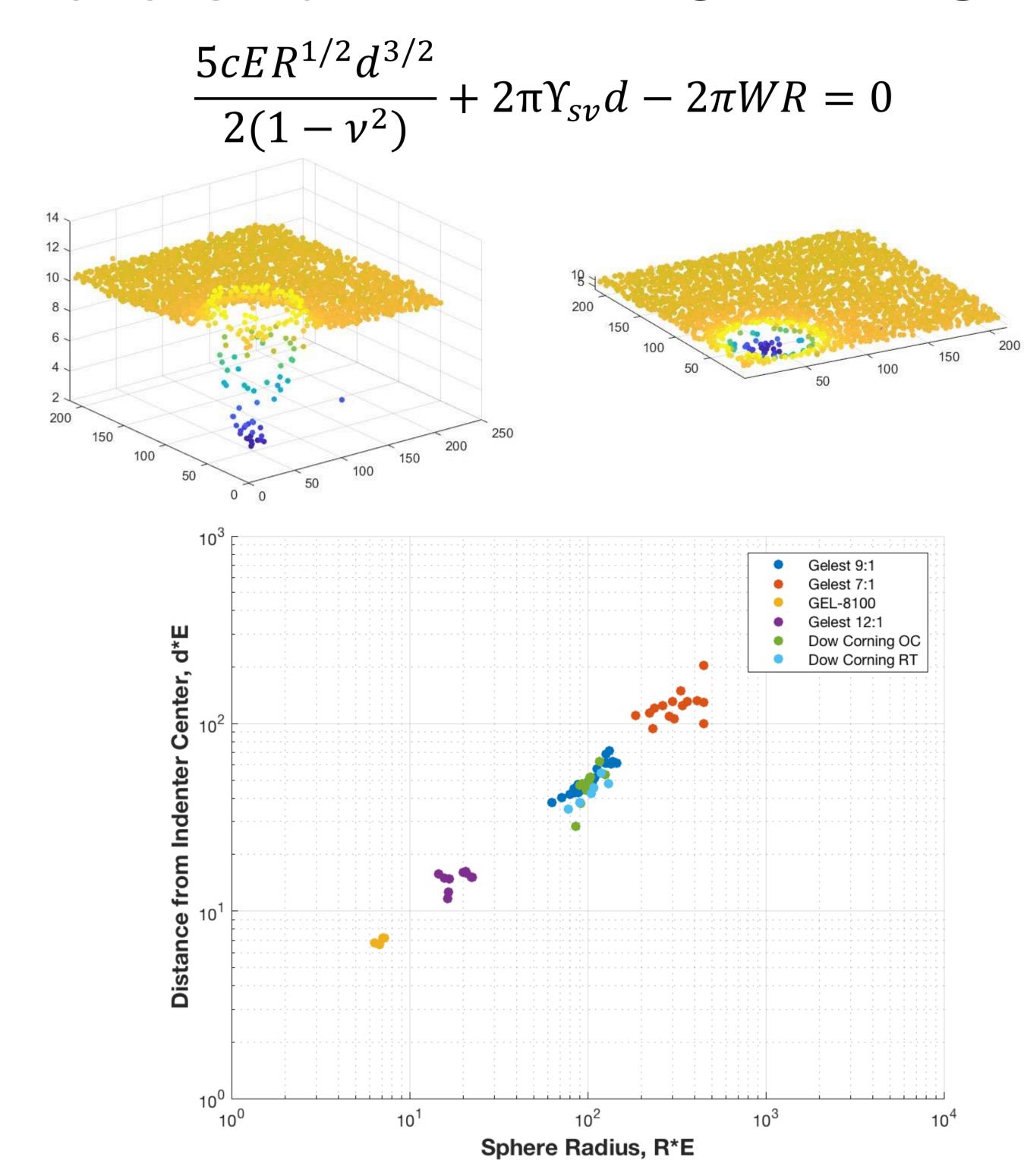
Homogeneous stretching is achieved using a custom-built stretching apparatus, milled out of aluminum and inset in laser-cut stage insert.







Preliminary Results: d vs R at zero strain with D.C. PDMS



Conclusions and Outlook

- Confirm new stretching apparatus is capable of long-term strain hold.
- Collect data and analyze strain dependence of PDMS (Silicone).
- Extend strain-dependent surface stress measurements to other materials.

