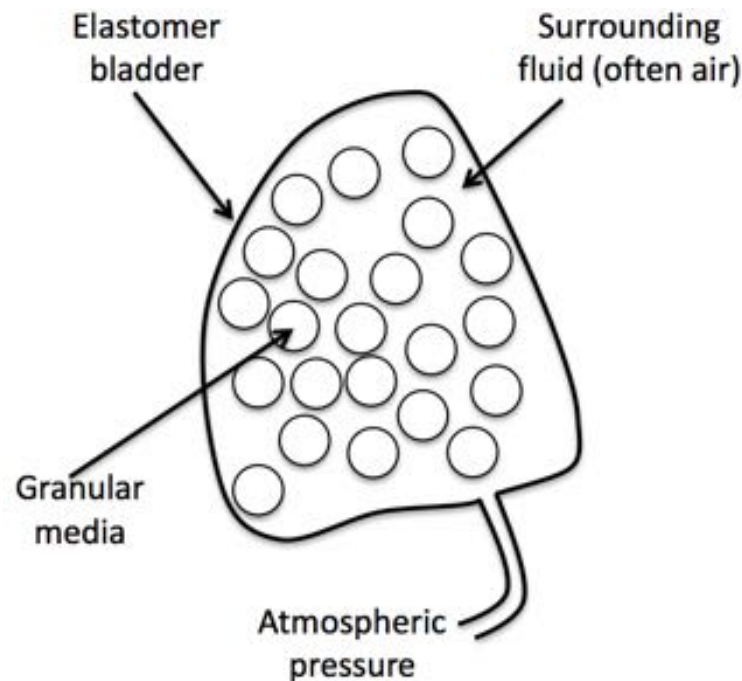


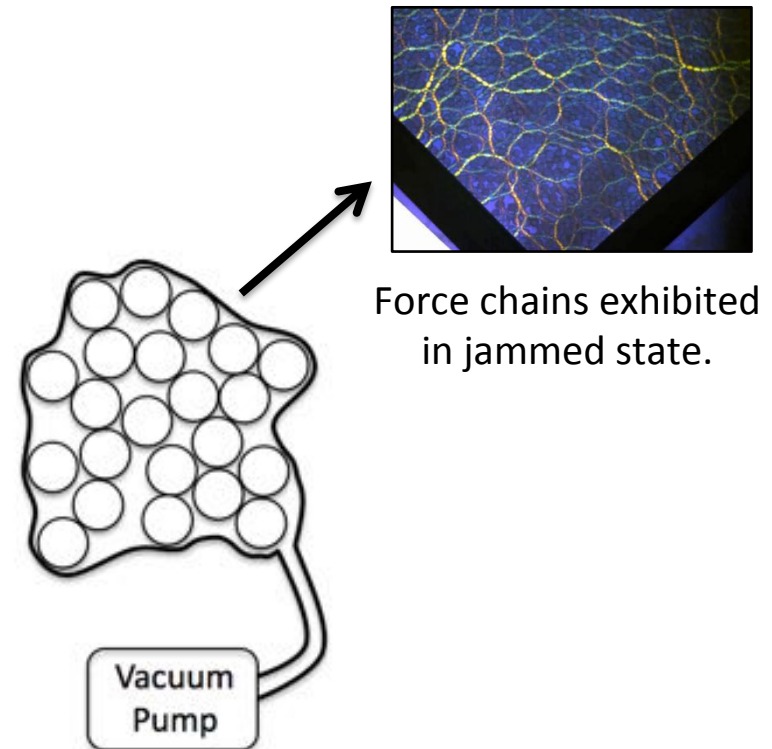
Experimental analysis on granular materials for robotics application

Katy Gero, Nadia Cheng, Karl Iagnemma, Anette Hosoi
Massachusetts Inst. Of Tech.

Robotic Applications: The Mechanism



flexible/un-jammed state



rigid/jammed state

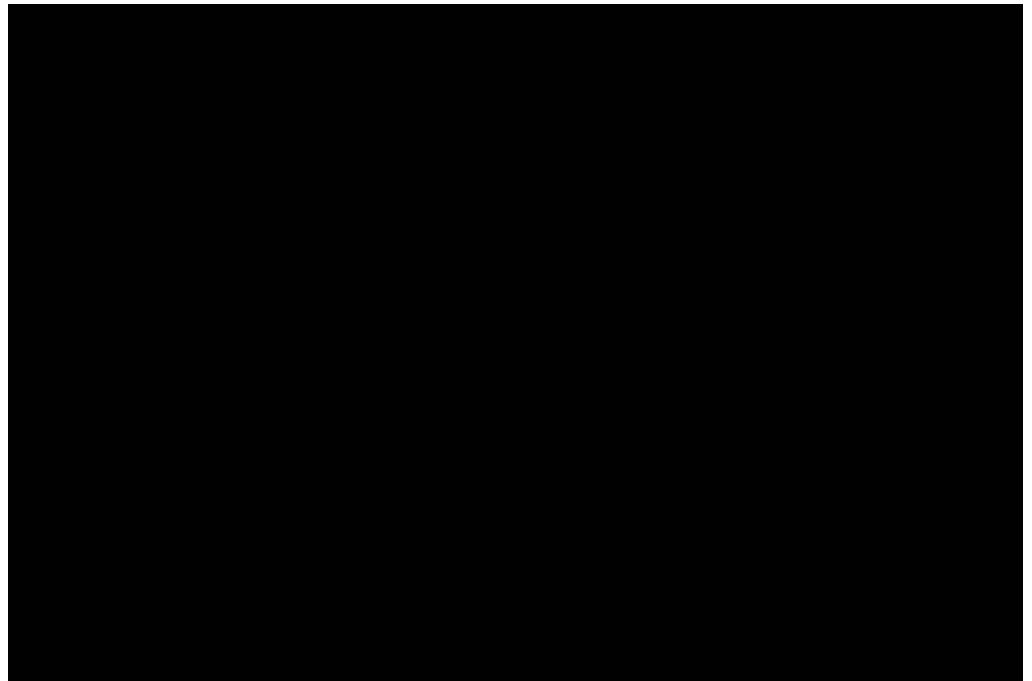
***Differential
jamming pressure:***

$$P_{atm} - P_{atm} = 0$$

$$P_{atm} - 0 = P_{atm}$$

Robotic Applications: Example

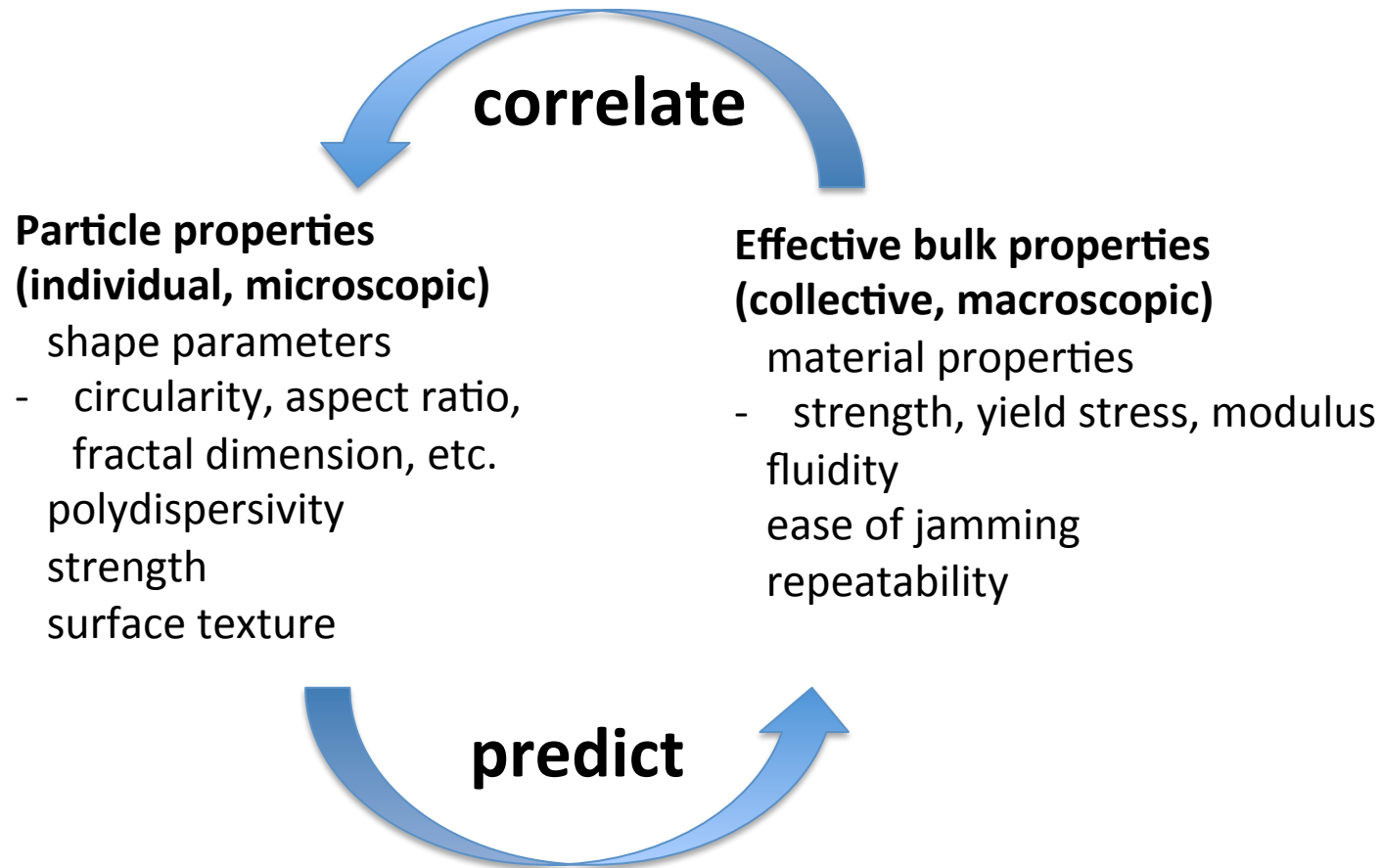
Trim video to start at 21s approx



Conformable gripper
by U of Chicago, Cornell, and iRobot

Amend, J.R., Jr., Brown, E., Rodenberg, N., Jaeger, H., Lipson, H.,
["A Positive Pressure Universal Gripper Based on the Jamming of Granular Material,"](#) IEEE Transactions on
Robotics, 2012, to appear.

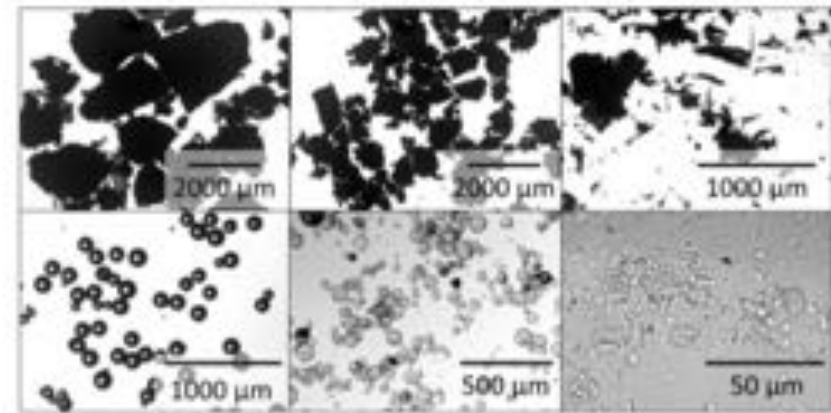
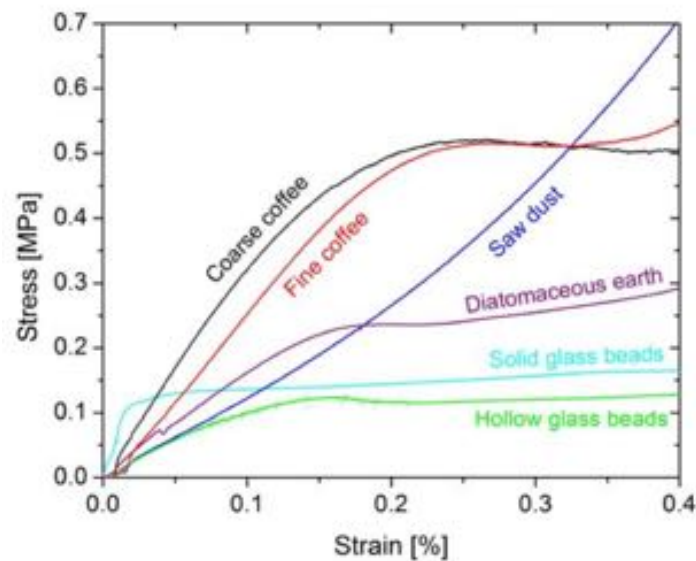
Experimental Study: Purpose



Changes in microstructure can lead to macroscopic changes.

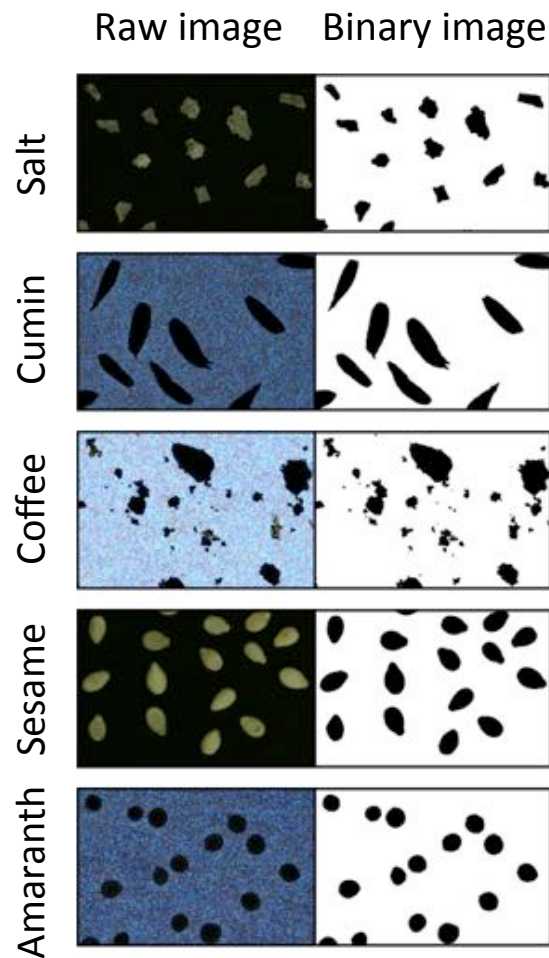
Experimental Study: Overview

Focus on shape and size distribution and strength properties:



Preliminary tri-axial tests for the specific case of high strength-to-weight ratio

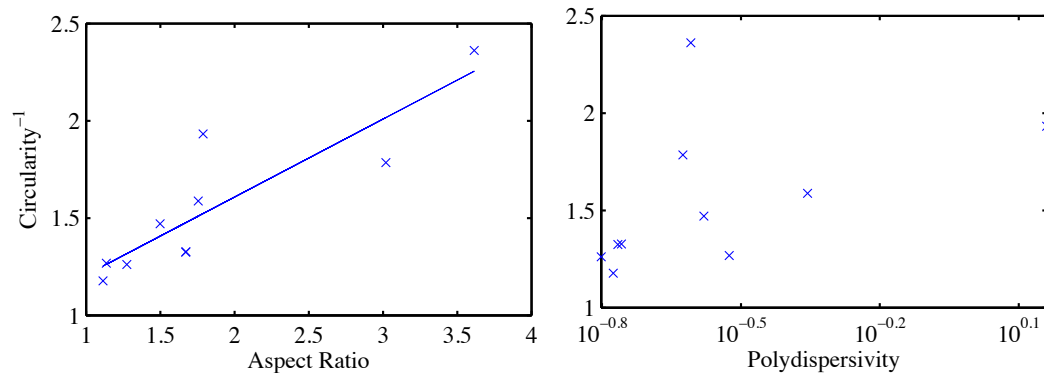
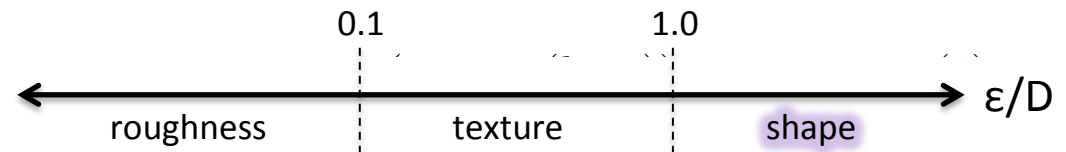
Experimental Study: Shape and Size



$$\text{Polydispersity} = \frac{\text{standard deviation of area}}{\text{average area}} \quad (1)$$

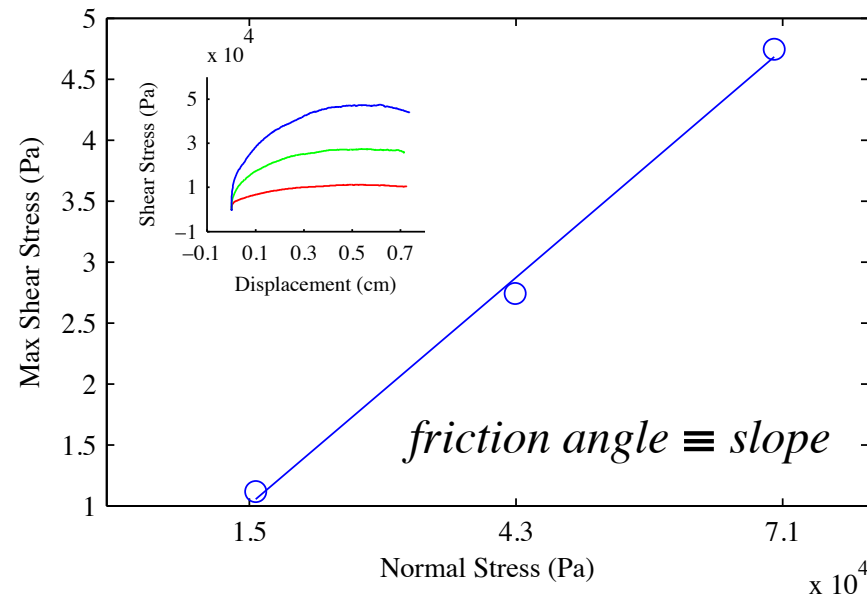
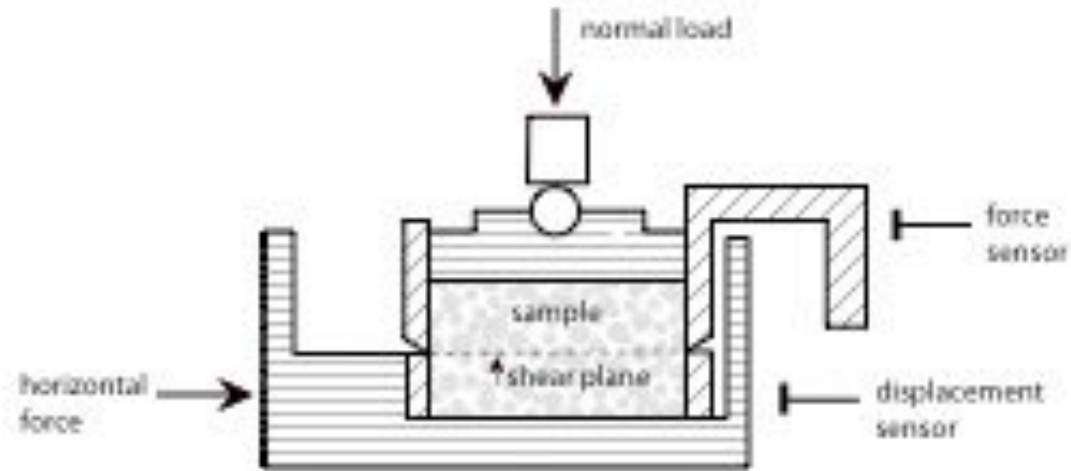
$$\text{Circularity} = \left(\frac{4 * \pi * \text{area}}{\text{perimeter}^2} \right) \quad (2)$$

$$\text{Aspect Ratio} = \frac{\text{major axis}}{\text{minor axis}} \quad (\text{of fitted ellipse}) \quad (3)$$

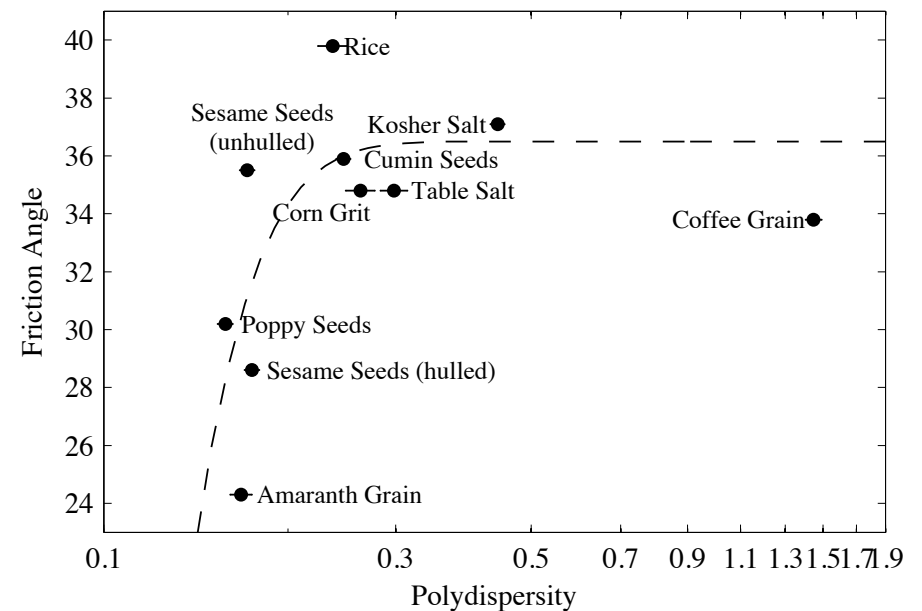
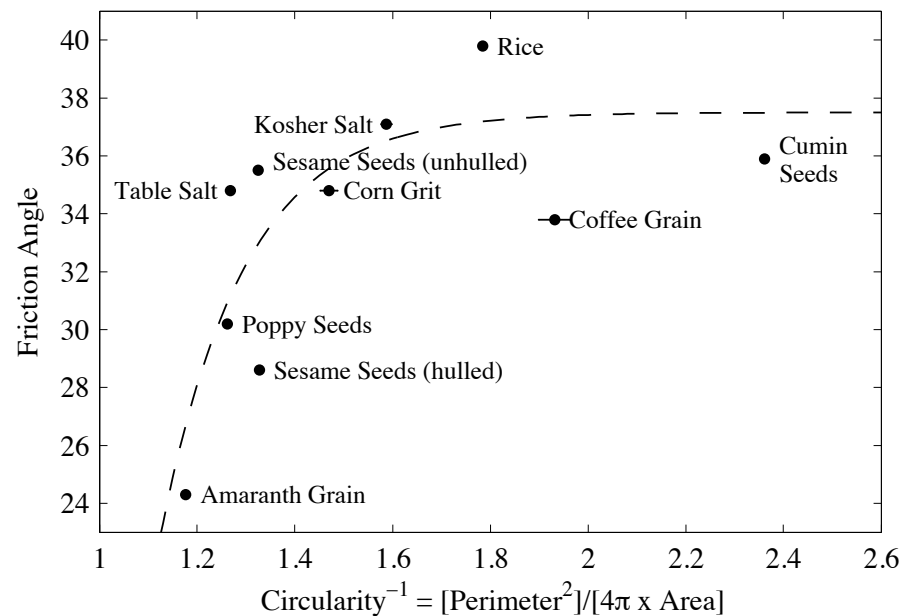


Aspect ratio and circularity are highly correlated.

Experimental Study: Shear Strength

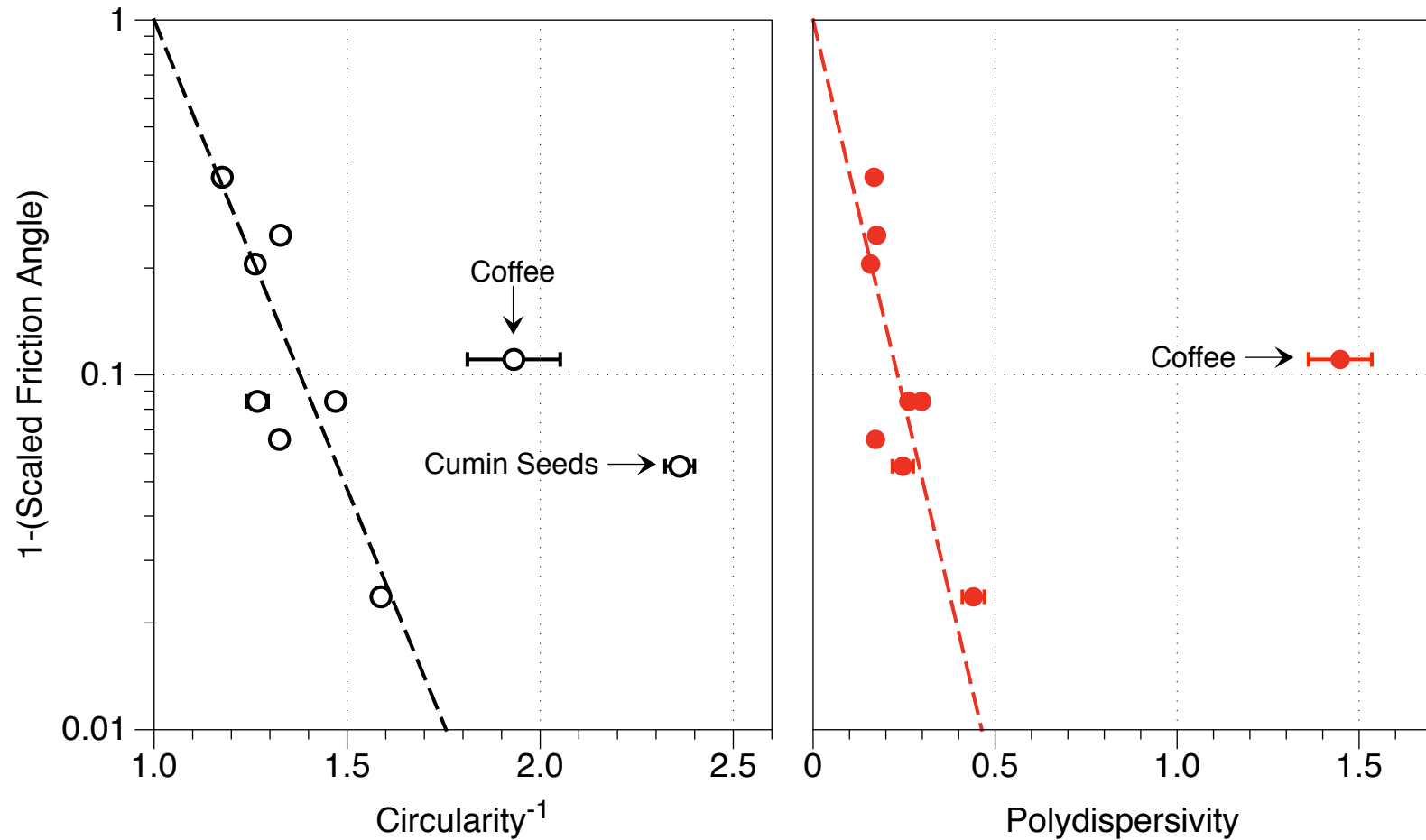


Experimental Study: Prelim. Results

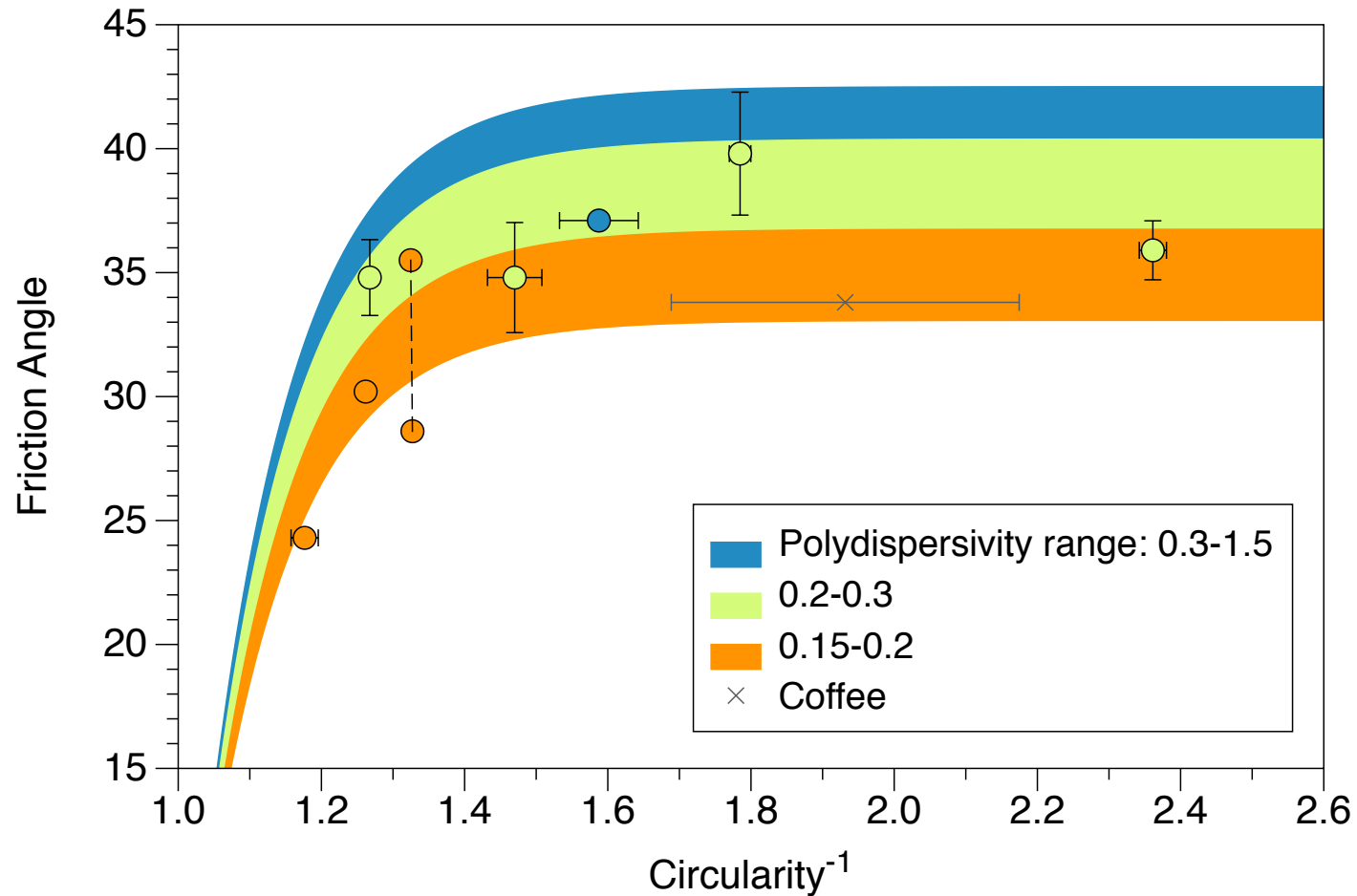


Asymptotic approach relationship.

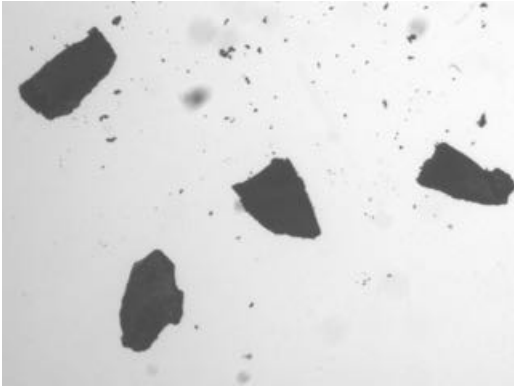
Experimental Study: Best Predictor



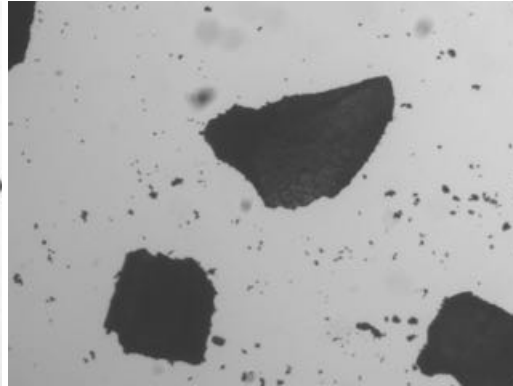
Experimental Study: Best Predictor



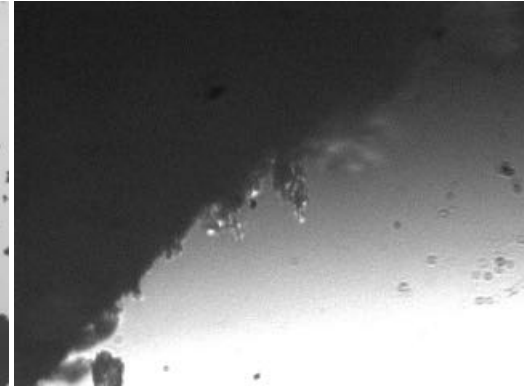
Further Studies: Particle Parameters



6.3x magnified
Corn grit



10x magnified



40x magnified
Surface roughness



3D printed particles



Controlling for variables

Questions?

