

Wet Fiber Deformability

Fiber Modification / Fiber-Fiber Bonding

Rob Lowe, Ph.D Student

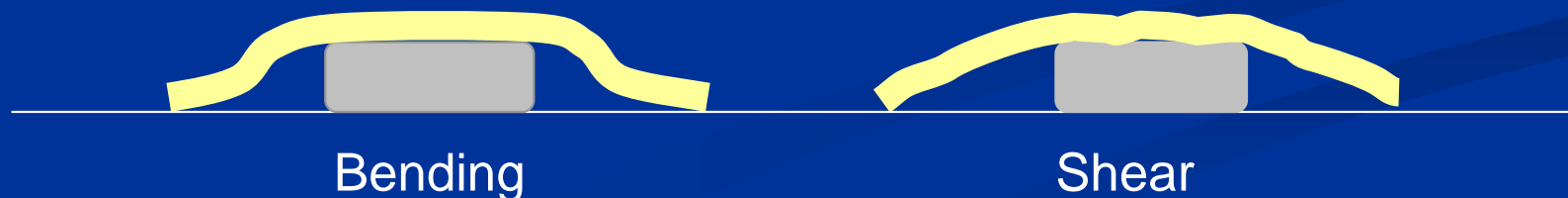
Art Ragauskas, Advisor

Flexibility, Conformability, Pliability, etc.

- WFF is linked to the ability of pulp fibers to consolidate into a paper sheet.
- Very important paper property
 - Apparent Density
 - Tensile
- Many ways to measure it
 - Seborg and Simmonds
 - Robertson
 - Mohlin
 - Tam Doo and Kerekes
 - Kuhn
 - Steadman

Measuring Wet Fiber Flexibility

- Most of these consider the fiber as an elastic beam. All the deformation is bending.
- Recent work has shown that shear is very important (Waterhouse and Page).
- No one has considered the plasticity of pulp fibers.



Wet Fiber Deformability

- Wet Fiber Flexibility
 - Chemical aspect of the fibers
 - Alone this would be relatively straight forward
 - No real research “meat”
 - Physical aspect of the fibers
 - Not well defined
 - New research raises questions about old methods
- Combine both into Wet Fiber Deformability

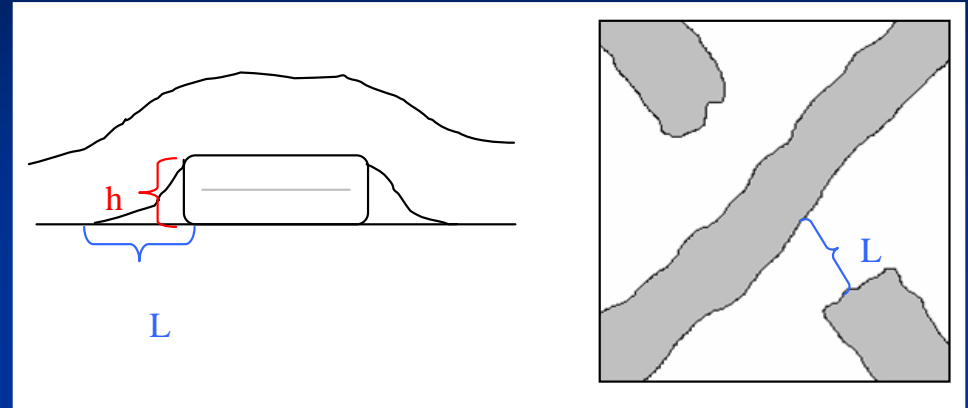
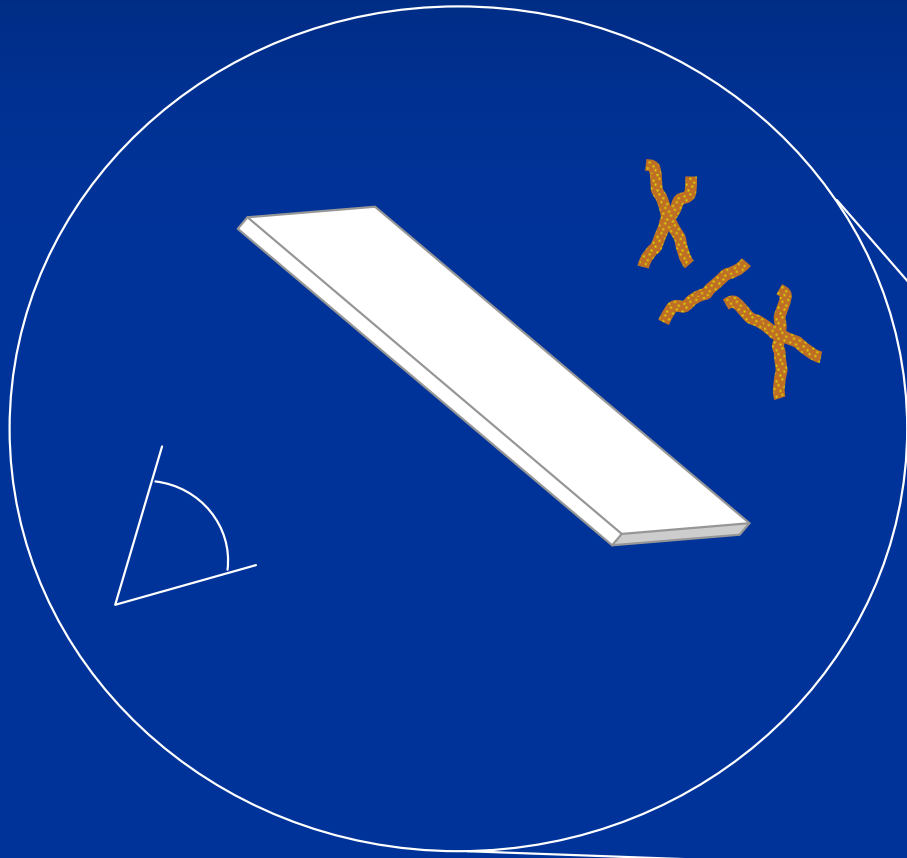
Wet Fiber Deformability

- Need for a fresh start:
 - Importance of shear
 - Plastic deformation
 - Realm of paper
 - A true wet measurement
- Deformability can incorporate all of this.

Wet Fiber Deformability

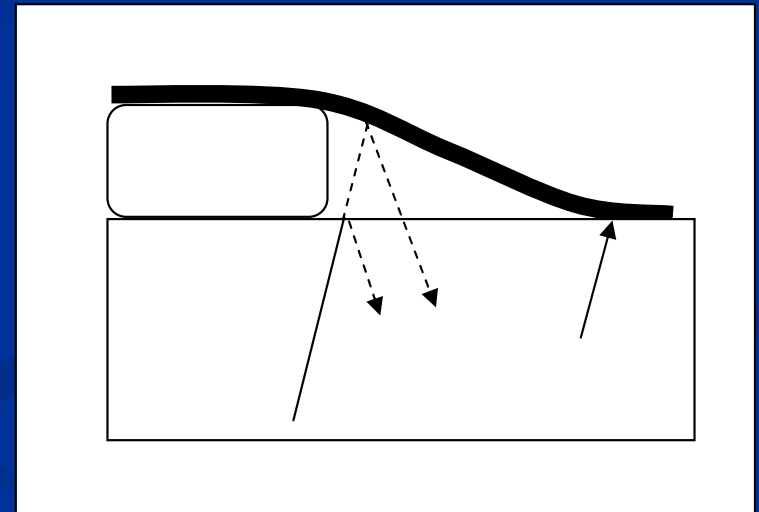
- The tendency of fibers to deform elastically and plastically in the z-x and z-y direction under stress in the z direction while in a water-swollen state.

What Are We Looking For?

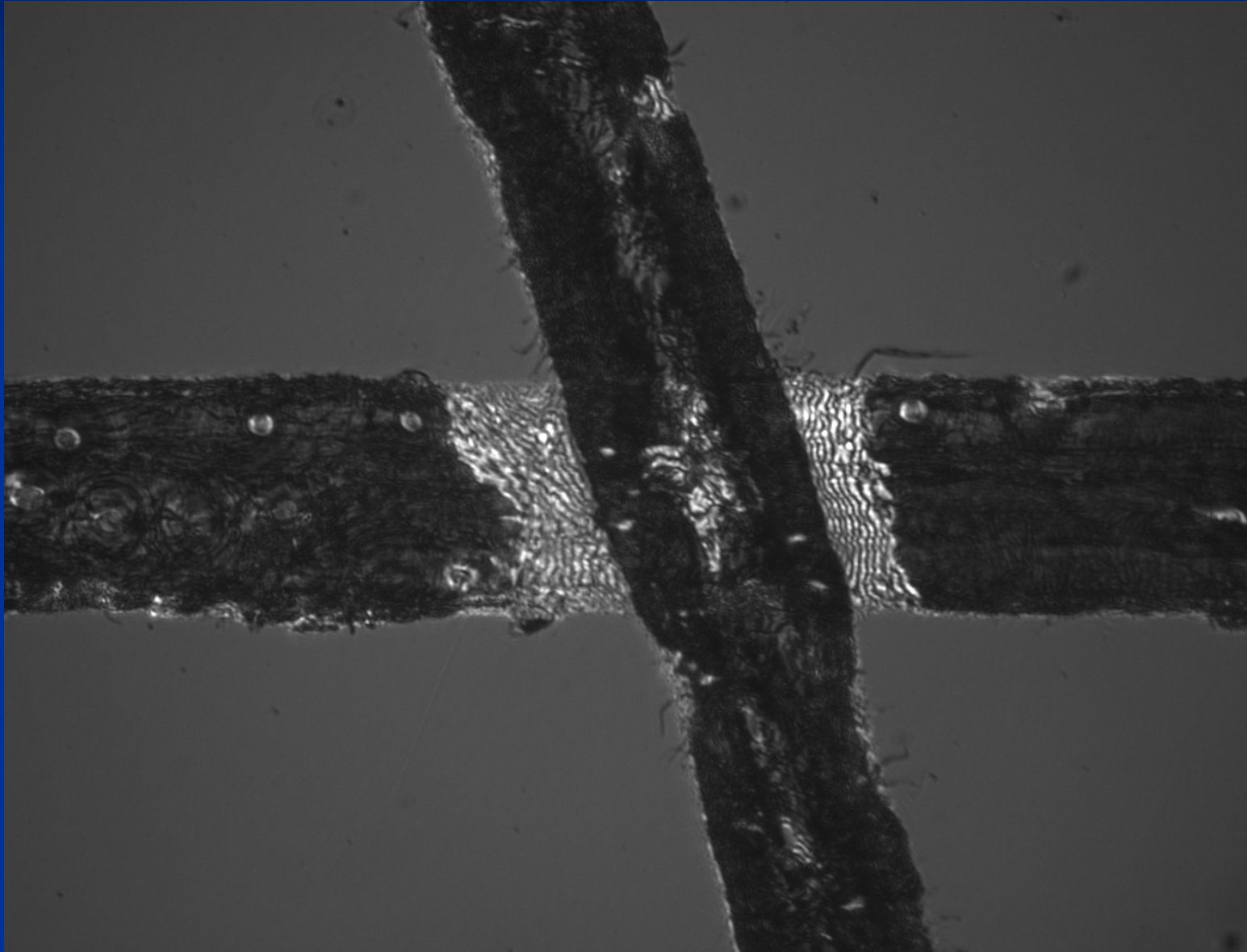


Measuring Deformability

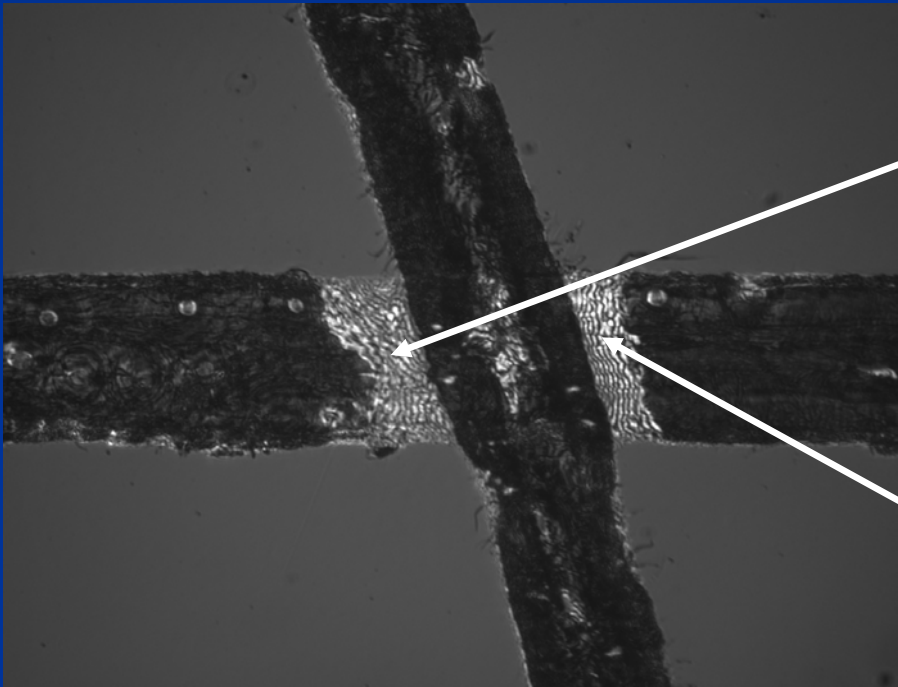
- We use the wavelength of light as a ruler.
 - Monochromatic light
 - $\lambda = 547 \text{ nm}$
- Each fringe occurs at $\frac{1}{2} \lambda$
 - $\frac{1}{2} \lambda \{\# \text{ of fringes}\} = \text{height}$



Measuring Deformability

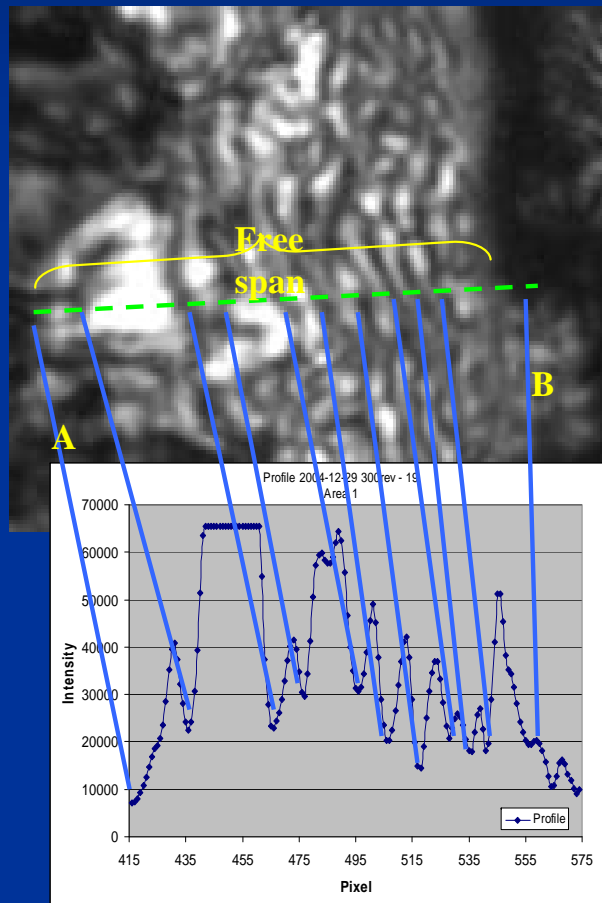


Measuring Deformability



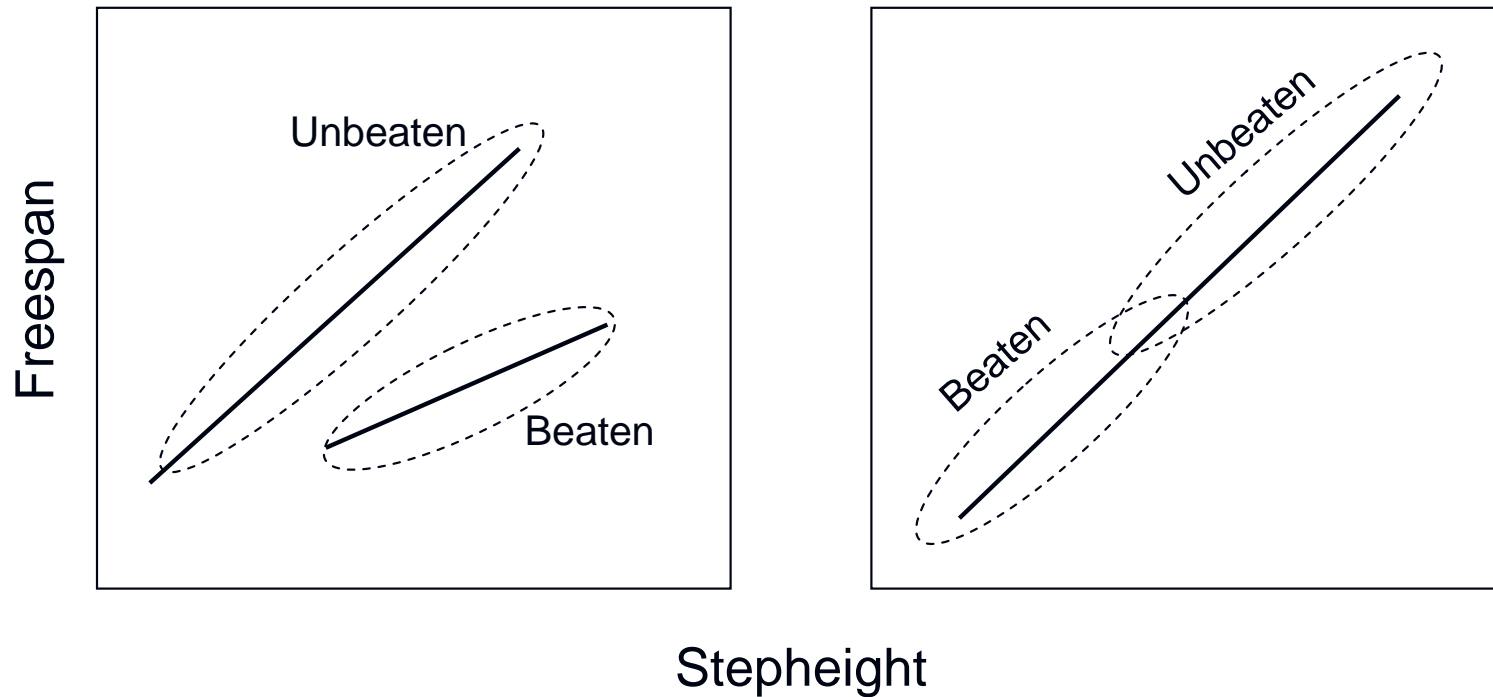
- Generally measured along the central axis.
- Area 1
 - Freespan = $17.3\mu\text{m}$
 - Stepheight = $1.19\mu\text{m}$
 - 7 fringes
- Area 2
 - Freespan = $13.0\mu\text{m}$
 - Stepheight = $1.19\mu\text{m}$
 - 7 fringes

Measuring Deformability

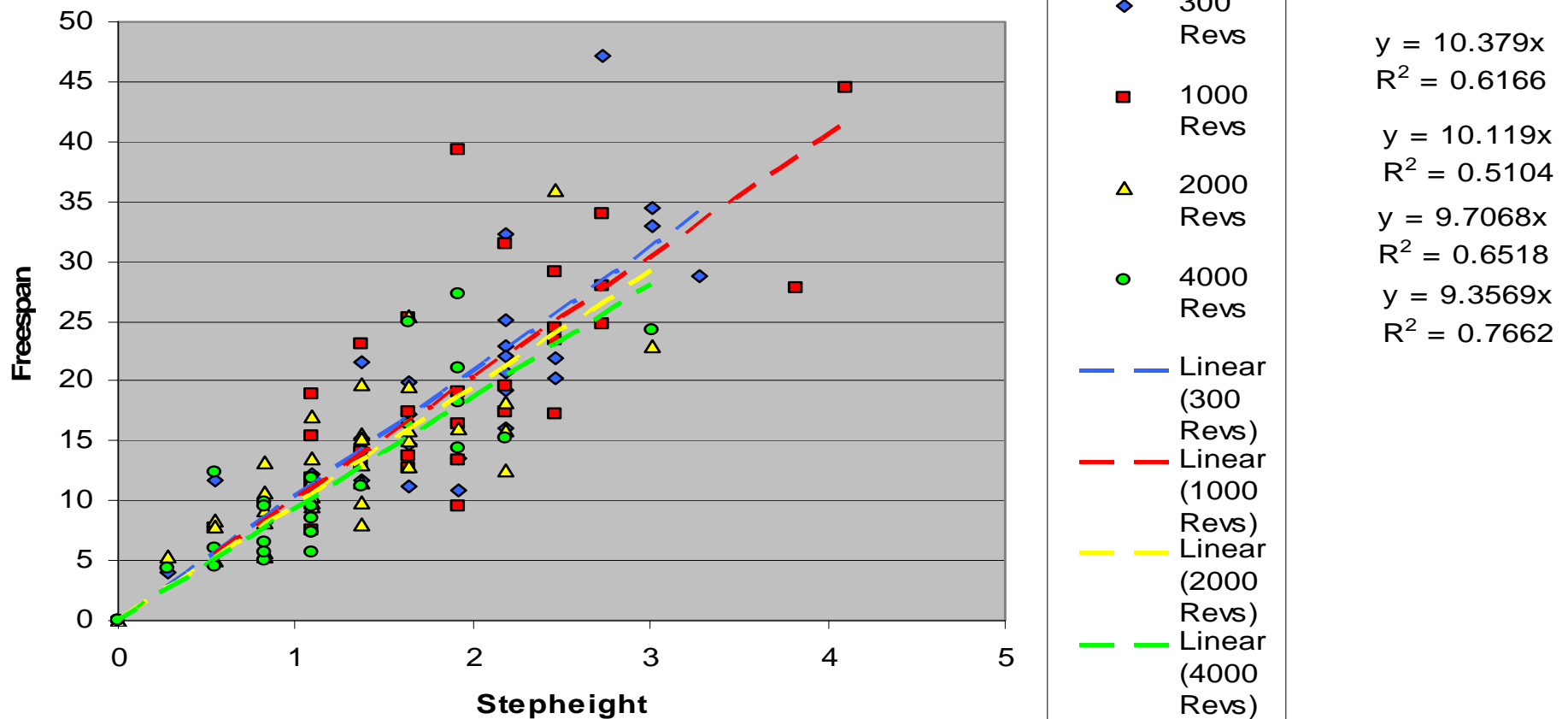


- Image Analysis
Software measures the intensity of each pixel or image element
- ~ 160 pixels
- A fringe occurs with a definitive change in direction of the intensity profile.
- 9 fringes

Measuring Deformability

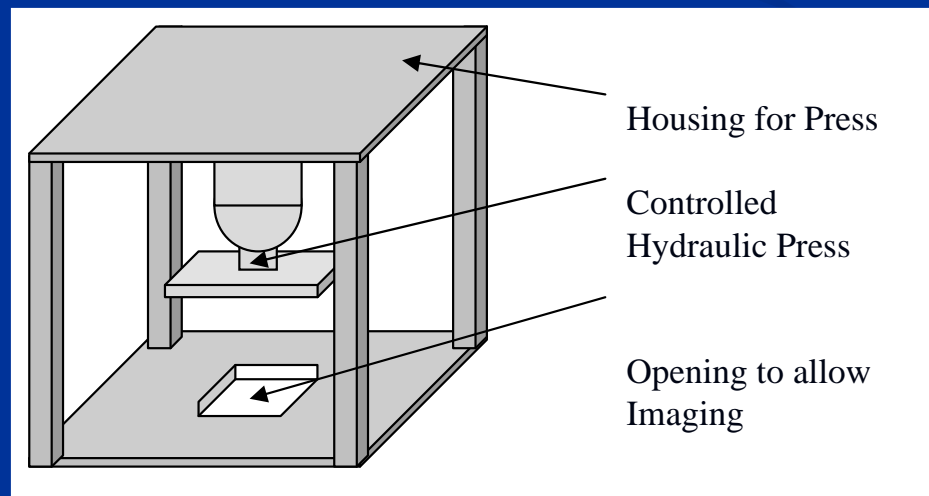
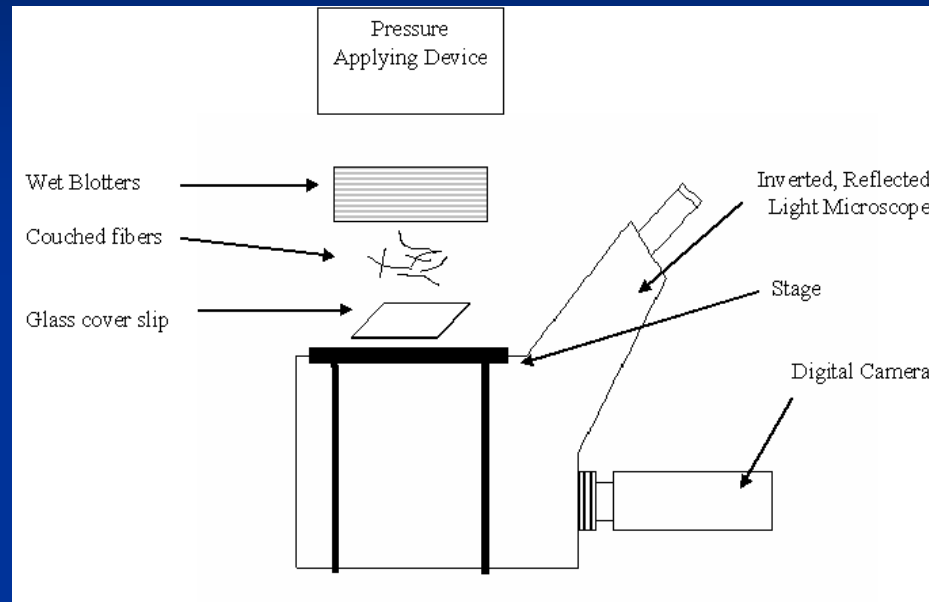


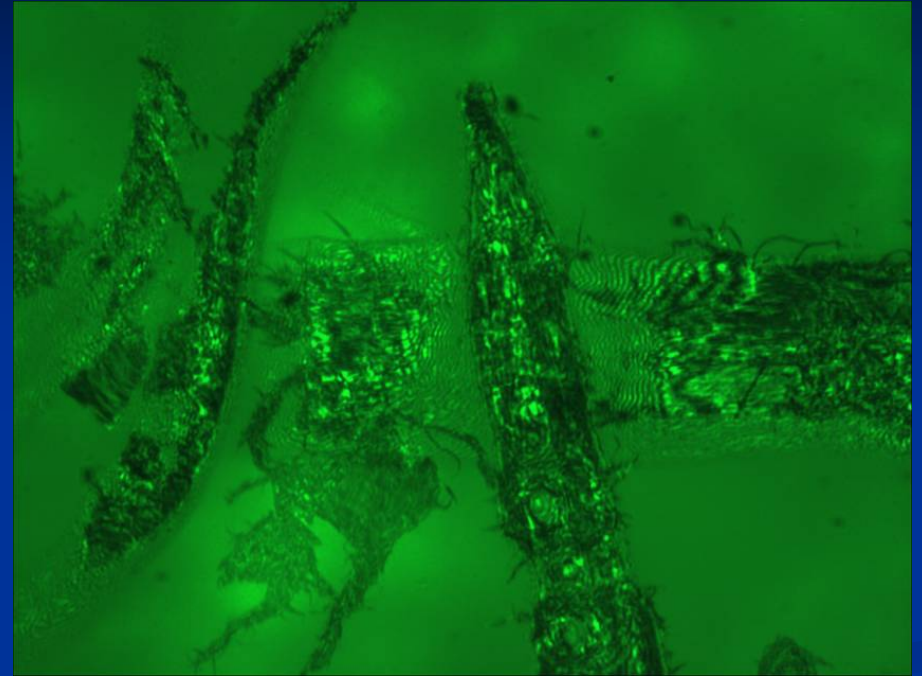
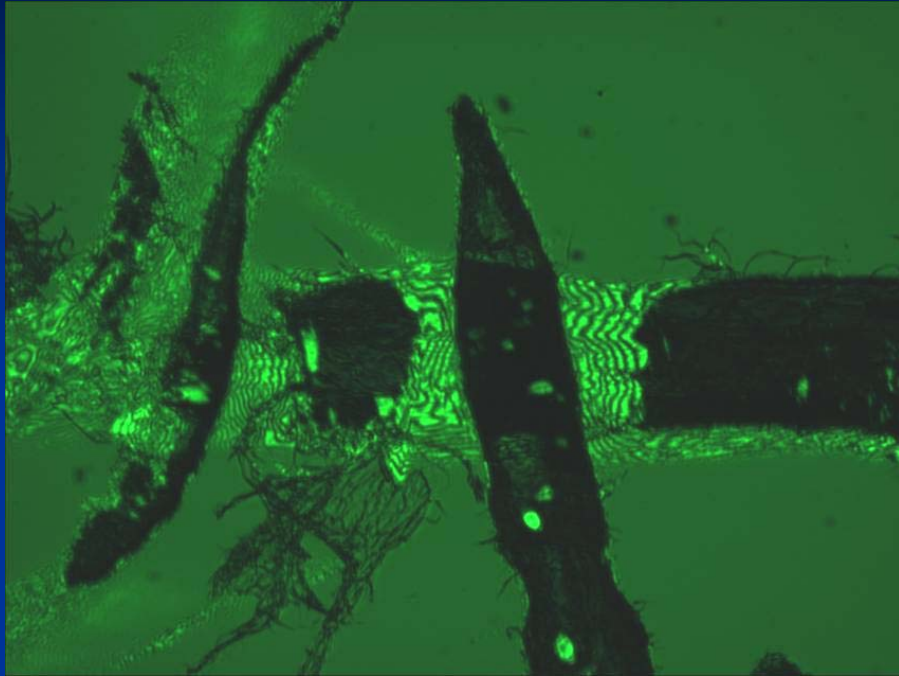
Measuring Deformability



- The effect of refining is to reduce stepheight.
- The main mode of deformation is shear.

Plasticity?





- Creating a new tool to examine the contribution of fiber chemistry to the physical properties of pulp fibers and paper sheets.