Friction Measurements on Cotton Fiber Bundles and Single Fibers

Farzad Hosseinali1, J. Alex Thomasson1, and James D. Batteas2,3

Motivations for studying mechanical and frictional properties of plant cells at the nanoscale:

1) Contact mode:
   - Obtained at different scan size; as can be noted cotton fiber has a bean-shape cross-section.
   - Schematic of tip-surface interaction for fibers with thin (a) and thick (b) cuticular layer.

2) The objective of this research was to measure and compare different surface attributes of cotton fibers using the AFM.

The main advantages of this mode are:

- Four scans per each sample are obtained from 2D SEM images with Canny operator (edge detection followed by series of dilutions and erosions).
- Micronaire Length [cm] Strength [g/tex] Elongation [%]

A (BRS 293) 0.080 4.7 2.8 32.1 7.4 8.4

B (Cotton 111S) 0.201 7.6 4.2 30.0 7.8 7.6

Our hypothesis was that the surface characteristics of cotton fibers vary between different cotton varieties since the macroscale frictional properties and the surface roughness of cotton fibers vary significantly among different cotton fibers.

Summary of Our Previous Study on Macroscale Fiber Friction

- Differences in fibers nanofriction were more apparent under higher normal forces.
- Differences are not clear at this scale of the sample A is 6.3 ± 1.2 nm, for B.
- The contact area between the AFM tip and fibers surface.
- Mean surface roughness of sample A is 6.3 ± 1.2 nm, compared to 45.5 ± 10 nN for sample B.

The main disadvantages of this mode are:

- The possibility of tip damage.
- It slid on their waxy layer.
- Abrasive friction led to wear in sample B.

Conclusions

- Surface topography images of cotton fibers show that a fiber bundle has lower friction coefficient than individual fibers. The higher the surface topography, the lower the friction.

References