

Morphology Characterization of Cotton Fibers

Image Analysis by microscopy

Cotton is a vegetable fiber which surrounds the seeds of the cotton plant, a shrub in the malvaceae family. The fiber is generally transformed into yarn which is woven to manufacture fabrics. Cotton has been used for millennia in the confection of fabric, with the earliest known use dating from 12,000 years B.C. in Egypt.

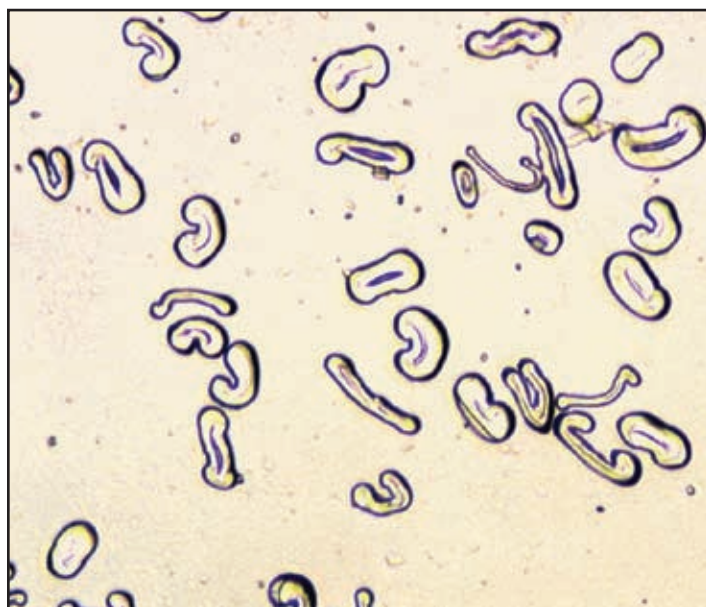
There are many types of cotton fiber. Thanks to advances in agronomy, and progress due to industrialization, cotton is the most important natural fiber in the world, making up more than half of textile fiber consumption worldwide. Cotton plants have also been cross-bred to form a wide variety of genera, and only recently has it been modified genetically to reduce heavy reliance on pesticides. Genetically modified cotton now accounts for a third of all cotton fiber sales worldwide.

The most common type of cotton originated from South America and is now cultivated in China, India, and the USA. It accounts for 81.5% of worldwide production. A Peruvian cotton, the *Gossypium barbadense*, now accounts for 6% of worldwide production. It is considered one of the best cottons in the world in terms of quality and length of fibers and is now mainly cultivated in Egypt.

Cotton's value is determined by taking samples from the dense bales resulting from the ginning of the cotton fiber. Each sample is classified according to fiber length (also called a staple), strength, micronaire, color, and cleanness. Intrinsic fiber strength is thought to be influenced by the structure of the primary and secondary cell walls of the fibers. As for a micronaire, it is the weight in micrograms per inch of fiber length. Optical microscopy can obviously be used to grade cotton color and cleanness, but it can also measure its staple and classify the structure of the fiber's cell walls to determine the cotton's strength.



Field of Cotton



Part of the original image at 400X for a calibration factor of 0.3342 micron/pixel..

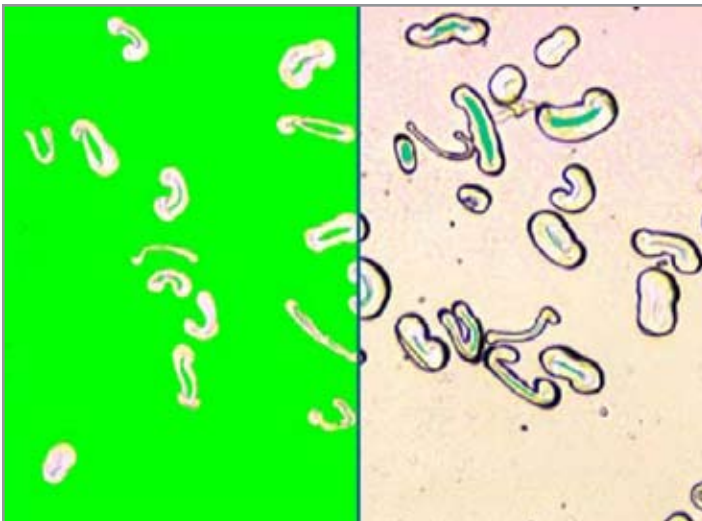
A sample of cross section of cotton fibers on a glass slide was analyzed at 400X. The purpose of this analysis is to discriminate cross section of cotton fibers (without lumens), and make measurements based on surface and shape with the image analysis system Clemex Vision PE.

The main difficulty of the analysis was to fill the small holes and scratches without removing the lumens. In fact, a large part of the analysis is dedicated to this task. Opening and Closing instructions were then required to maintain the original size of the objects. One requirement was to discriminate objects at the midpoint of the fiber black outlines, this specification is arbitrary and could be easily altered. A Thickening instruction was then used to thicken objects without them touching each other. A Transfer instruction was used on three separate occasions because it combines several intermediate operations that would otherwise have been required.

Some objects overlapped each other. Most of them were separated or discarded (size Transfer) but despite all precautions some still overlapped. These remaining objects are negligible considering total number of objects (1,915). The size-based Transfer also removes objects that are too small to be cotton fibers.

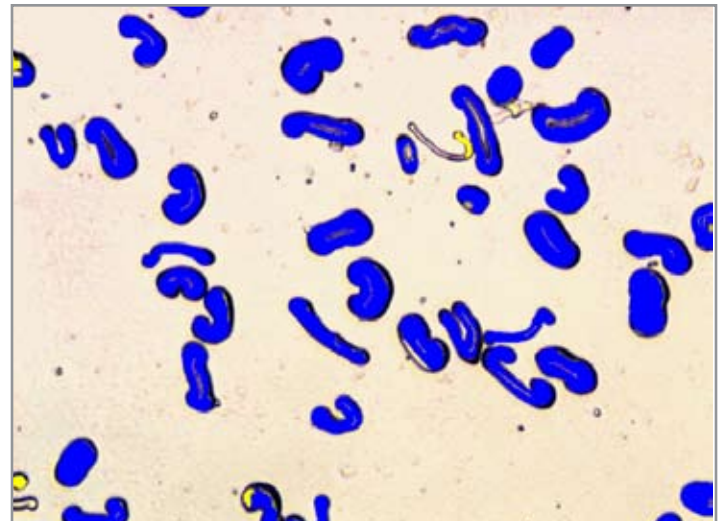
A Guard Frame was applied to eliminate all incomplete objects at the edges of each field. Objects that are eliminated are necessarily analyzed in a subsequent field since the stage moves in guard frame size steps. That is the reason why fields are 26 400 μm^2 rather than 33 460 μm^2 (full image size).

The same analysis was repeated several times and the results are highly reproducible. The results can also be exported in MS Excel to offer many valuable statistical tools and substantial graphical versatility.



Rough detection of lumens by inverting the cotton fibers detection

Final detection of lumens obtained by using a transfer function.



Final image before measurements.

Results Summary	Area (micron ²)	Perimeter (microns)	Length (microns)	Sphericity (ratio)
Minimum	20.1	15.8	5.9	0.1
Maximum	299.8	99.6	33.8	1.0
Average	121.12	50.04	18.04	0.61
Standard Deviation	54.07	13.90	4.83	0.19

