SOUTH WEST RESEARCH CENTER FOR LAUNDRY AND DRYCLEANING COMES TO ITC

The Southwest Drycleaners Association (SDA) has relocated to the ITC their research and training facility, the Southwest Research Center for Laundry and Drycleaning (SRCLD). State-of-the-art equipment will be installed later this year. The SDA will conduct workforce training classes at the ITC. Dr. Noureddine Abidi, ITC textile chemist, will be responsible for developing the research program in fabric care and treatment, utilizing the equipment. This will enable the ITC to develop an integrated research/technology-transfer/education program extending from raw fibers through garment care.

SPINNING LAB READY FOR NEW MACHINERY

The ITC cotton spinning laboratory is looking very impressive these days. It is being prepared to receive three new ring spinning frames, a new carding machine, and a new drawframe.

NEW INSTRUMENTS NOW AVAILABLE

The ITC has installed two new instruments: a Sun Protection Factor (SPF) analyzer and a Raman System spectrometer. The SPF analyzer measures the penetration of ultraviolet (UV) rays and quantifies the protection provided by a fabric or other materials. The Raman spectrometer uses a fiber-optic probe for identification of diverse materials or substances present on fibers and textiles. Dr. Noureddine Abidi will use these instruments for research and to provide testing and evaluation services to the fiber/textile industry.

COMPUTER SPECIALIST JOINS ITC

Mrs. Kshama Salvi is now managing computer information systems. Besides maintaining and developing computer resources, she will write custom software programs and integrate them with hardware for research and administrative applications.

STAFF TRAVEL

- Dean Ethridge, Noureddine Abidi and Pam Alspaugh to Fort Worth, Texas for the convention and trade show of the Southwest Drycleaners Association, March 17–19.
- Dean Ethridge to Memphis, Tennessee for a meeting of the Committee on Cotton Quality Measurements, March 30–31.
- S. S. Ramkumar to Manchester, England for the 80th World Conference of the Textile Institute, April 9–20.
- Dean Ethridge to Austin, Texas for the 89th Annual Convention of the Texas Cotton Association, April 26–27.

COTTON FIBER PROPERTIES SEMINAR TO BE HELD JULY 11-12 AT ITC (See back page for more details)
INTRODUCTION

Maturity of the cotton fiber is generally understood as the amount of secondary cellulose contained relative to the perimeter of the fiber. Thus, it is the interior area (A) of the cell wall, excluding the lumen, relative to the perimeter (P) of the fiber. These are illustrated in the following figure:

![Diagram of cotton fiber maturity](image)

The maturity level of a fiber is defined as the “circularity” or “degree of thickening” of the fiber, and is commonly denoted by the Greek letter \( \theta \). From the two parameters A and P, the \( \theta \) may be calculated using the following equation (Thibodeaux):

\[
(1) \quad \theta = 4 \frac{\pi A}{P^2}
\]

Genetic or biological fineness is defined as the perimeter (P) of the cross section of the fiber—or as the diameter of a perfectly circular cross-section. This implies that A and P fully describe cotton fiber fineness and maturity.

Using a computerized image analysis technique, cross-sectional measurements were made on selected cotton fibers and the relationship between such measurements and the fiber length distributions was examined.

PROCEDURES

There have been many different methods used for embedding fibers for microscopic examination of cross sections; e.g., use of corks, carrots, steel and aluminum plates, plastic slides, etc. These various mediums were all used to hold a fiber bundle rigid while making a cross cut of the sample. Generally microtomes are used to slice very thin cross sections of the fibers for viewing with a microscope. The effectiveness of an embedding method is judged by how well it enables viewing the fiber cross sections in an undistorted state; i.e., without the artifacts of the embedding material confusing the observations through the microscope.

The method used here was developed at the Southern Regional Research Center in New Orleans, Louisiana, USA (Boylston, et. al.). It uses a methacrylate polymer to hold the cotton fibers in order to cut them with a rotary microtome into 1-micron thick slices, then mounting on glass slides for observation. Approximately 500 fibers are captured in each sample.

The prepared glass slides were viewed with a computerized video microscope, which captures the magnified images and stores them in computer files. These images then remain available for use in measuring area and perimeter of the fibers.

Alternative software packages were used to take the computerized measurements of the fiber cross sections. Ultimately, a software package (Fiber Image Analysis System) developed by Bugao Xu, University of Texas at Austin, was determined to be the best one for our purposes.

For this study, four samples were selected from International Cotton Calibrations Standard (ICCS) cottons. The selected cottons, along with some important fiber properties, are as follows:
Fibronaire
Micronaire
Fibrograph
2.5% Span Length (in) 1.05 1.15 0.93 1.33
50% Span Length (in) 0.50 0.53 0.41 0.60
Uniformity Ratio (%) 48 46 44 45

Stelometer
Tenacity (g/tex) 19.2 22.4 19.8 33.3
Elongation (%) 6.6 6.1 6.8 6.2

The A21, C37, and G21 are Upland type cottons, while the D6 is a Pima type cotton.

In order to investigate relationships between the image analysis results and fiber length distributions, each of the cottons were sorted by length using the comb sorter. Then cross section samples of approximately 500 fibers were prepared for each length category.

RESULTS

Validation of Image Analysis Procedures
Exhibits 1 – 4 show the visual differences among the four cottons chosen. Cotton A21 is quite coarse with a high level of maturity. Cotton C37 is also quite coarse but has a much lower maturity level. Cotton G21 is coarse but has a very low maturity level. Finally, cotton D6 is a fine fiber and exhibits a high level of maturity. Exhibits 5 – 7 show the distributions of perimeters, areas, and theta values derived from the image analysis using hand prepared samples. The following conclusions apply:

<table>
<thead>
<tr>
<th>Exhibit</th>
<th>Image of Fiber Cross Sections: Cotton</th>
</tr>
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<tbody>
<tr>
<td>1.</td>
<td>A21</td>
</tr>
<tr>
<td>2.</td>
<td>C37</td>
</tr>
<tr>
<td>3.</td>
<td>G21</td>
</tr>
<tr>
<td>4.</td>
<td>D6</td>
</tr>
</tbody>
</table>
• **Perimeter** – The Pima cotton, D6, consists of fibers with the smallest perimeters; i.e., has the finest fibers of the four cottons considered. Cotton G21 exhibits the largest (coarsest) fibers among the four cottons. The cottons A21 and C37 fall in between and are quite similar in their perimeter distributions.

• **Area (A)** – Cotton D6 also consists of fibers with the smallest areas. However, cotton G21 exhibits an area distribution that is comparable to C37 and has the second-smallest average area. The large perimeters and small areas indicate that G21 consists of immature fibers. The distribution for Cotton A21 reveals that its fibers have the largest areas.

• **Maturity (θ)** – Cotton D6 exhibits the highest average maturity level and Cotton G21 exhibits the lowest. As expected, cotton G21 has a high percentage of the fibers in the very immature part of the distribution. Cottons A21 and C37 peak at the same theta value, but C37 has more fibers in the immature portion of the distribution.

Exhibit 8 contains a summary of average values and the coefficients of variation (CV%) for P, A, and θ for each of the four cottons. The averages are as expected,
given the results already summarized above. However, there are some notable differences in the coefficients of variation. The CV% values are largest for the area ($A$), followed by those for the maturity ($\theta$), with those for the perimeter ($P$) being smallest. The relatively small values for the CV% of $P$ are not surprising, given that it is determined to a greater extent by genetics and a lesser extent by environment than are the other two parameters.

These results are generally satisfying because they confirm what was already known about the ICCS cottons and the microscopic images. They encourage us to continue development of this methodology for establishing reference measurements for cotton fiber fineness and maturity. The next step was to investigate the relationship between fiber length and maturity.

**Fineness/Maturity Measurements vs. Length Distributions**

Of primary interest are the significant correlations that may exist between levels or intrasample CVs of the measurements and the length distributions of the fibers. A positive correlation means that the measurements will tend to increase as the fiber length increases, while a negative correlation means that the measurements will tend to decrease as the fiber length increases.

Exhibit 9 summarizes the correlations between $P$, $A$ and $\theta$ and the fiber length categories.

- For $P$, only the cotton C37 has a significant positive correlation; therefore, the perimeter size of C37 fibers increases as the length of these fibers increases. For the other three cottons, there is no

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**EXHIBIT 7. Theta Distributions of Selected ICCS Cottons**

![Theta Distributions of Selected ICCS Cottons](image)

**EXHIBIT 8. Average Parameter Values and Associated CVs**

<table>
<thead>
<tr>
<th></th>
<th>ICCS Cottons</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A21</td>
</tr>
<tr>
<td><strong>Averages</strong></td>
<td></td>
</tr>
<tr>
<td>$P$</td>
<td>56.4</td>
</tr>
<tr>
<td>$A$</td>
<td>137.2</td>
</tr>
<tr>
<td>$\theta$</td>
<td>0.554</td>
</tr>
<tr>
<td><strong>CV%</strong></td>
<td></td>
</tr>
<tr>
<td>$P$</td>
<td>19.4</td>
</tr>
<tr>
<td>$A$</td>
<td>30.9</td>
</tr>
<tr>
<td>$\theta$</td>
<td>26.4</td>
</tr>
</tbody>
</table>
significant tendency for perimeter size as fiber length increases.

- For A, only cotton C37 exhibits a significant positive correlation. Thus, the area of C37 increases as fiber length increases.
- For θ, three of the four (all but G21) exhibit significant positive correlations. This means that all but G21 tend to show increased maturity as the fibers get longer.

Exhibit 10 illustrates the relationship between maturity (θ) and length (L) for cotton A21. The significant increasing tendency in maturity for the longer fibers implies that it is important to get a representative sample, containing all lengths of the fibers present in the cotton, in order to get a good estimate of either the average maturity or the variation in maturity.

Exhibit 11 summarizes the correlations between the CVs of P, A and θ and the fiber length categories.
EXHIBIT 12. CV% of Maturity vs. Length: Cotton A21

\[ CV\%_\text{of } \theta = 33.6 - 10.67 L \]
\[ r = -0.96 \]

- For the CV% of P, cottons C37 and D6 have significant negative correlations; therefore, the CV% of fiber perimeter for these two cottons decreases as their fiber lengths increase.
- For the CV% of A, all of the cottons but G21 exhibit significant negative correlations with fiber length. Thus, the CV% of areas of the other three cottons tested tends to decrease as fiber length increases.
- For the CV% of \( \theta \), two of the four cottons (A21 & D6) exhibit a negative correlation with fiber length; this indicates that variations in maturity are smaller among the longer fibers.

Exhibit 12 illustrates the relationship between the coefficient of variation of maturity (CV% of \( \theta \)) and length (L) for cotton A21. The significant decreasing tendency in CV% of \( \theta \) for the longer fibers implies that there is greater variability in the shorter fibers than in the longer fibers. Logically, this variability may have two causes: (1) an inherent tendency for the native shorter fibers to be more irregular in maturity, and (2) a tendency to break the ends off of fibers during ginning and other handling, thus creating more variable \( \theta \) values. The challenge presented by these causes is to have good sampling procedures, in order to get cross sections of all the length categories.

**CONCLUSION**

Results to date indicate that image analysis techniques used in this study are appropriate for developing a greatly improved reference method for measurements of the fineness and maturity of cotton fibers. Reliable results require that samples tested include all the length categories; however, this is probably not feasible with hand preparation of the samples. The use of Fibrograph combs should provide a more appropriate method for getting samples that contain little or no length bias in them.

Results also revealed that measurements of fiber maturity (\( \theta \)) are quite likely to be positively correlated with fiber length, while the coefficients of variation (CV%) for maturity (\( \theta \)), perimeter (P) and area (A) are quite likely to be negatively correlated with fiber length. Therefore, while image analysis provides the definitive reference method for determining the fineness/maturity of cotton fibers, valid sampling procedures and careful sample preparations are preconditions for accurate measurement results.

**REFERENCES**


SIXTH ANNUAL COTTON FIBER PROPERTIES SEMINAR

July 11-12, 2000
International Textile Center
Texas Tech University, Lubbock, Texas

Cotton fiber properties are a primary research interest of the ITC. Each year the ITC offers in-depth training on cotton fiber properties, testing, and evaluation of test results in a seminar for the cotton/textile industries. This seminar is for cotton breeders, textile mill cotton buyers, merchants, researchers and others who work with cotton, have fiber tested and must interpret that data. The date of this seminar rotates throughout the year.

The first day of the seminar includes fiber properties, testing, (including HVI, AFIS, yarn testing, and stickiness) and interpretation of data. Demonstrations of tests are done in the Materials Evaluation Lab. The second day covers how cotton fiber properties impact textile processing with demonstrations in our research textile mill. Sessions will be taught by ITC staff; Eric Hequet, assistant director; Pauline Williams, materials evaluation manager; James Simonton, textile engineer; and Bill Cole, special projects and training, and S.S. Ramkumar, research associate.

Seminar fee is $250 and includes a large reference notebook, transportation from the hotel to the ITC, and two lunches.

Four Points by Sheraton Hotel, 505 Ave. Q, 806-747-0171 is the seminar hotel. Tell the hotel you are attending the ITC Cotton Fiber Seminar for a special room rate of $55/night plus a free breakfast buffet. On arrival at Lubbock International Airport, call the hotel from the direct phone in the baggage claim area and they will pick you up. Southwest, Continental, American, and Delta airlines serve Lubbock.

Photocopy this form and fax to 806-747-3796 and mail check to ITC
Call Pam Alsough at 806-747-3790 or e-mail ict@ttu.edu for additional information

Name ________________________________

Firm or agency ________________________________

Address ________________________________

City, State, Zip ________________________________

Phone __________________ Fax __________________ email ________________

Registration fee $250 (includes seminar, 2 lunches, notebook, transportation from hotel to ITC)
Checks payable to: International Textile Center
Mail to: ITC, Box 45019, Lubbock TX 79409-5019
Confirmation and schedule will be faxed back on receipt of registration fee
Registration Deadline: June 27, 2000
Hotel reservations—Four Points by Sheraton Hotel, 505 Ave. Q, Lubbock 806-747-0171.