Measuring Cotton Fibre Fineness using the Sirolan-Laserscan.

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Introduction

CSIRO Wool Technology in Geelong has traditionally focussed on 'post-farm' wool research but is now expanding its activities to include textile related research and development for the wider Australian industry, including cotton. With approximately 200 staff at its laboratories and full mill processing facility in Geelong, CSIRO Wool Technology has extensive expertise in raw wool measurement and characterisation, wool textile processing, characterisation and optimisation of wool fabric properties and the development of new wool products. Much of this expertise can be applied to other fibres as illustrated in the current paper. In a preliminary study the Sirolan-Laserscan, developed at Wool Technology for measuring the fibre diameter characteristics of wool, has been successfully applied in a novel mode of operation to accurately assess cotton fibre fineness.

Cotton fibre fineness and maturity are key quality parameters for cotton. Unfortunately current commercial methods of assessing these parameters are inaccurate. The Micronaire value, determined from an Airflow technique, is a measure of the average fibre surface area of a sample. As such, micronaire is a compound of both fibre fineness (mass per unit length) and maturity. It has been estimated that micronaire represents two-thirds fibre fineness and one-third maturity (Steadman, 1997). Recent experience has shown that for many cotton varieties the micronaire value may not be a good indicator of either property (Williams and Yankey, 1996). This leads to ambiguity in commercial trading with sometimes a buyer arguing that a low micronaire reading denotes immaturity whereas the seller interprets it as fineness (Steadman, 1997).

Steadman's recent paper(1997) reviews the various other techniques that have been applied to measuring fibre fineness and maturity. To date, no satisfactory approach has been established for routine commercial testing.

The Sirolan-Laserscan

In commercial trading, the fineness of wool samples has, for many years, been determined using an airflow technique similar to that used for the micronaire measurement. As wool fibres are approximately circular in cross-section, the results of this test are expressed as a mean fibre diameter. For the Australian wool clip, typical mean fibre diameter values are between 18 and 24 μm with differences of 0.1 μm being significant commercially.

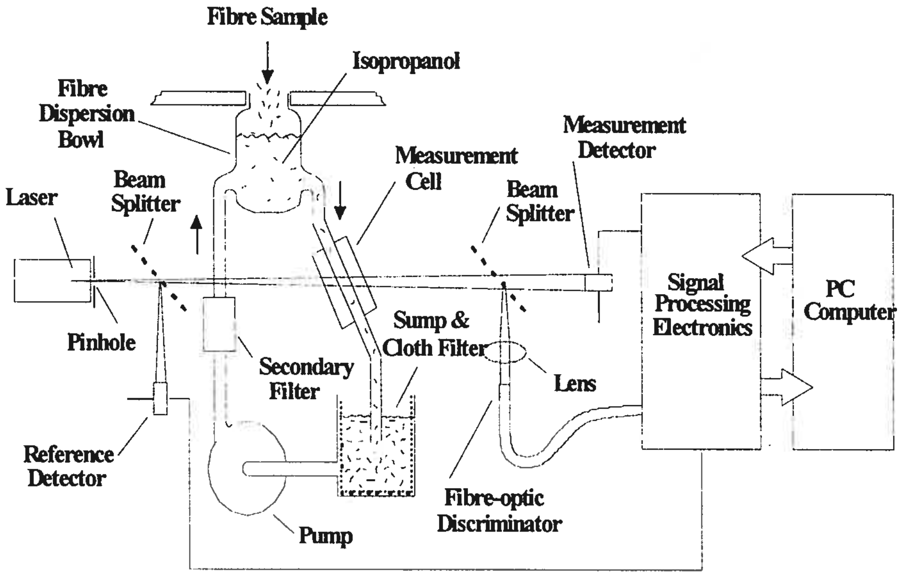


Figure 1. Schematic Diagram of Sirolan-Laserscan

The Sirolan-Laserscan was developed at CSIRO Wool Technology as a commercial instrument for the rapid measurement of the full fibre diameter distribution of wool samples (IWTO, 1993). The technique, illustrated schematically in Figure 1, suspends fibre snippets in an isopropanol-water mixture that transports them such that they individually cross the path of a laser beam. The fibre diameter of each fibre snippet is determined from its interaction with the laser light. The Sirolan-Lasercan technique is now an approved test method for commercial testing of wool samples and is being used by the trade worldwide.

The availability of fibre diameter distribution information for wool samples has lead to important advances at CSIRO Wool Technology on the role of diameter distribution in wool spinning (Lamb et al, 1992) and in fabric skin comfort (Naylor and Phillips, 1996). Some commercial mills are now specifying fibre diameter distribution characteristics and not just mean fibre diameter in order to control and improve their product quality.

Gordon (1995) tried to use the Sirolan-Laserscan to measure the properties of various cotton samples that he had characterised carefully as part of his Ph.D (Gordon, 1994). He observed some correlations between the Sirolan-Laserscan outputs and various fibre characteristics. For example, there was a relationship between the Sirolan-Laserscan mean fibre diameter and the fibre fineness. However Gordon noted that the sample of immature cotton was generally an outlier. Gordon concluded that none of his observations were statistically meaningful enough to warrant further investigation.

Results

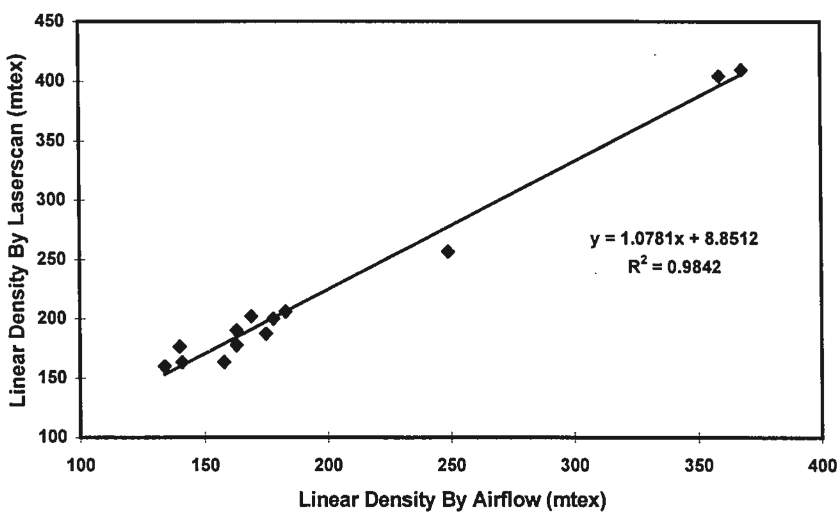
Fortunately most of the Gordon's samples were available and formed the sample set for the current preliminary study. A summary of Gordon's data for the available samples is listed in Table 1. The maturity and linear density values were determined by a double compression airflow technique.

Table 1.

Stuart Gordon's Results			Laserscan Results
Sample No.	Maturity Ratio	Linear Density (mtex)	Linear Density (mtex)
7	0.88	141	163
8	1.02	183	206
10	1.00	175	187
USDA13	0.61	140	177
USDA14	0.79	134	160
USDA16	0.94	158	163
USDA19	0.95	249	257
USDA21	0.92	368	410
USDA22	1.00	359	404
24	0.95	163	190
32	0.99	178	200
36	0.81	163	178
42	0.98	169	202

It was noted that in building up histogram information, the Sirolan-Laserscan acts as a fibre snippet counter as well as an instrument for measuring fibre fineness information. This was used as the basis of a gravimetric determination of fibre fineness expressed as a weight per unit length (dtex). Figure 2 shows the relationship between the Sirolan-Laserscan measured linear density values and those obtained by Gordon. Note the good relationship and the fact that in contrast to Gordon's results, the very immature sample is not an outlier.

Figure 2. The relationship between the fibre fineness (expressed as a linear density) measured using the Sirolan-Laserscan and the linear density measured using a double compression airflow technique.



These preliminary results indicate that, in this novel mode of operation, the Sirolan-Laserscan can be used to determine the average fibre linear density or fineness of cotton samples. Following this successful preliminary study it is planned to continue to evaluate the potential of the Sirolan-Laserscan approach for measuring not only average linear density but also fineness distributions and fibre maturity information.

Acknowledgments

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