Cotton fibre maturity measurement using SiroMat

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Australian production and harvest practice means that mature and immature cotton bolls are picked alike. Cotton fibre maturity becomes an issue in this blended harvest when it is presented for processing. This is because the proportion of immature cotton fibres (fibres where there has been insufficient time for adequate cell wall thickening) has an adverse affect during processing.

It is well known amongst spinners and fabric manufacturers that immature fibres introduce problems during the blending, cleaning, spinning and dyeing processes.

Traditional direct methods of measuring cotton fibre maturity (that directly assess the cell wall thickness of each individual fibre) are slow and laborious. Indirect methods of maturity measurement, which perform measurements on fibre bundles, provide results much quicker than the direct methods. But they suffer on the basis that they measure fibre parameters that are not solely related to fibre maturity.

SiroMat automatically scans across the slide.

Currently the most popular method of measuring fibre maturity (the micronaire), cannot reliably distinguish between two fundamentally important fibre properties — fibre fineness and fibre maturity. Because micronaire actually measures specific surface area, it is unable to distinguish between fine mature fibres and coarse immature fibres.

Immature (left) and mature (right) bolls.

FIGURE 1: Field of view for mature (left) and immature fibres

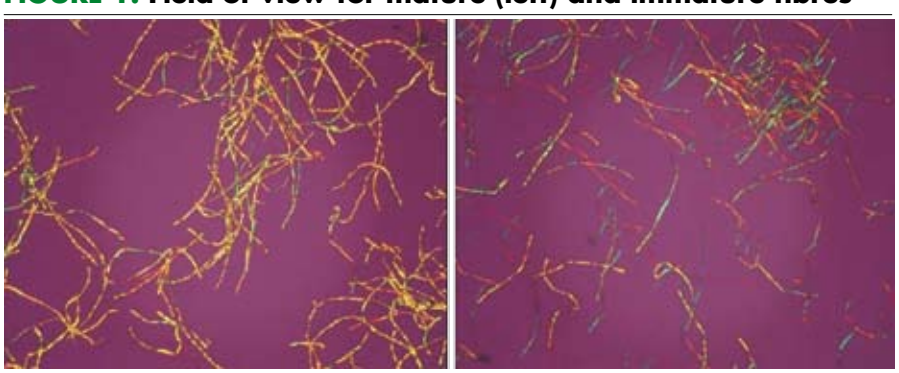

TABLE 1: Average results from SiroMat

	Maturity	Ave skew	Ave SD
Immature	0.44	0.07	0.49
Mature	0.97	0.05	-0.27

Answers in colour

Under development at CSIRO Textile and Fibre Technology, SiroMat is a new method of directly measuring cotton fibre maturity based on the polarised light microscope method. This method identifies fibre maturity by the interference colours displayed by fibres when viewed through crossed polars.

Mature fibres transmit yellow or yellow-green light under this arrangement while immature fibres appear blue or orange. The original standard method requires an operator to identify and count the number of mature and immature fibres based on the appearance of colour.

This method was time consuming and operator dependent — that is, the assessment of colour can differ between operators.

SiroMat incorporates image analysis and colour processing techniques to digitally identify and measure cotton fibre maturity based on the colours displayed by the fibres.

As a simple demonstration of SiroMat's ability to measure fibre maturity, the fibres in two bolls (see photo), one mature and the other immature, were tested.

To test samples on SiroMat, around two milligrams of fibre snippets were obtained from each sample and these were spread evenly onto a microscope slide. An immersion media was applied and another microscope slide used to cover the prepared snippets.

The slide was then placed onto the microscope stage ready for measurement. No conditioning of fibres is required because the technique is not weight based. SiroMat automatically scans across the slide

collecting and analysing the fibre colours displayed. When completed, a maturity distribution histogram is displayed along with the average maturity value, standard deviation and skew of the distribution in the sample tested.

What the colours tell us

Figure 1 shows single fields of view (FoV) under the SiroMat for each sample and illustrate the difference in fibre colour displayed by mature (left) and immature (right) fibres. Mature fibres appear yellow whilst immature fibres appear orange or blue depending on their orientation to the crossed polars. The results from SiroMat are shown in Table 1.

As expected, the results show that the immature boll sample contained fibres with a very low average maturity value and the mature boll sample contained fibres with a high average maturity value.

In addition to this, SiroMat highlighted that the fibre maturity distribution of the immature sample had a positive skew — that is more fibres at lower maturity values with a tail towards higher values, while the mature sample had a negative skew — more fibres at higher maturity values with a tail towards lower values (see Figure 2).

The potential of SiroMat is its ability to distinguish fibre samples on the basis of their maturity and the distribution of maturity within a fibre sample. Test speeds are comparable to other low volume instruments and so it has great potential for use as a stand alone instrument in classing houses and research laboratories, and also as a reference measurement to calibrate the faster indirect methods currently used. Over the next year, CSIRO Textile and Fibre Technology, the CRDC and the Cotton Catchment Communities CRC will be working towards the commercialisation of the SiroMat.

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FIGURE 2: SiroMat maturity distribution