



# FINAL REPORT

*(due within 3 months on completion of project)*

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## *Part 1 - Summary Details*

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**Cotton CRC Project Number:** 4.01.05 (CRC 1008)

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**Project Title:** Technical support of SiroMat on the Australian Market

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**Project Commencement Date:** 7/2009

**Project Completion Date:** 6/2011

**Cotton CRC Program:** Value Chain

## *Part 2 – Contact Details*

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### ***Part 3 – Final Report Guide (due within 3 months on completion of project)***

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#### ***Background***

The objectives of the proposed project were to:

- (i) Support the technical transfer of the current SiroMat instrument to the new licensee for two years;
- (ii) Introduce and test the new commercial instrument in HVI classing/testing rooms in Australia and within research laboratories in USA and China.
- (iii) Use SiroMat in current cotton projects including the CCC CRC Agronomic Textiles; the CRDC Premium Quality Initiative; the CRDC Improving the Nep Levels in Australian Cotton and the CCC CRC Cottonspec projects.

All these objectives were achieved.

During the course of this project BSC Electronics changed the name of the SiroMat instrument to Cottonscope. BSC Electronics formed a company called Cottonscope P/L to build and market the Cottonscope instrument. Six months into the project BSC Electronics approached CSIRO to incorporate the CSIRO and CRDC Cottonscan technology into the Cottonscope. The combined instrument now provides direct measures of maturity and maturity distribution and ribbon width and ribbon width distribution in the specimen, and average linear density. It completes measurement of these properties on 20,000 x 1 mm fibre snippets in 30 seconds. Agreement of maturity and linear density values with fibre cross-section reference values is excellent. The agreement has been corroborated by Texas Tech.

At the time of writing five Cottonscope instruments have been bought or are being used on approval before buying. Cottonscope instruments are located at CMSE Belmont, CPI Narrabri, the USDA ARS SRRC New Orleans LA, Texas Tech University Lubbock TX and Dai Chung Textiles Ltd., Guangdong (owned by Central Textiles Hong Kong).

The next two years will be important in terms of extending and marketing the instrument, and testing iterations expected in the software, sample preparation procedures and linkages with other test instruments, e.g. HVI, and quality prediction systems, e.g. Cottonspec. In September 2011 agents of BSC Electronics will exhibit Cottonscope at the Barcelona ITMA. In February 2012, the instrument will be displayed by CSIRO at the Australian Cotton Seminar in Chongqing, China. To this end, CSIRO have submitted a PRP to the CRDC for funding to support Cottonscope in 2012/13.

The first inter-laboratory trials between CSIRO and Texas Tech for the combined Cottonscope instrument are also underway (July 2011). As well as comparing laboratory results these trials will also provide the market with evidence of Cottonscope test results against the test results of the 104 Texas Tech reference cottons analysed by cross-sectional analysis, and test results by alternate, indirect instruments such as the Uster AFIS PRO and Shirley Developments FMT. The comparisons being made in this work, which will be published in a peer review journal, will provide a watershed in the testing of cotton fibre maturity and fineness.

### ***Project Objectives***

The stated objectives of the project and their achievement status are listed in Table I below.

**Table I – Project objectives, milestones, performance indicators and achievement**

<b>Objective</b>	<b>No.</b>	<b>Milestone</b>	<b>Performance Indicator</b>	<b>Achieved</b>
Successfully transfer SiroMat technology to new licensee	1.1	SiroMat technology successfully transferred	New prototype instruments are near test readiness by December 2009	✓
Use current and/or newly licensed SiroMat to assess samples from a range of projects.	2.1	SiroMat data is reported and analysed for selected industry funded projects.	SiroMat data gives insight into effects of crop, gin and mill management	✓ ongoing
	2.2		SiroMat instruments are used in spinning mills to assess fibre laydown quality	✓ ongoing
Collaborate with USDA and Texas Tech on series of papers (2 or 3) describing bias and error associated with SiroMat and/or Cottonscan data	3.1	First paper tended to publishing journal	Random error and bias tests complete	✓
	3.2	Second paper tended to publishing journal	Classic maturity and fineness models tested (using Cottonscope combined instrument)	✓ in preparation

### ***Methods***

The technical activities (the methods) followed during this project reflect BSC's development schedule for the SiroMat technology – see Table II. The development schedule was tended to CSIRO by BSC in late 2008, although transfer of SiroMat to BSC did not occur until July 2009 after the licensing agreement had been signed. The schedule describes timelines and tasks for the transfer and development of the technology, e.g. the production and testing of a commercial prototype and its software, but does not give specific marketing and extension plans. Many of the technical tasks were revisited during the project; notably after iterations to the software and sample preparation methods.

Specific test results and methodologies are described in the papers written during the course of this project. A list of papers and posters is given on Page 6 of this report.

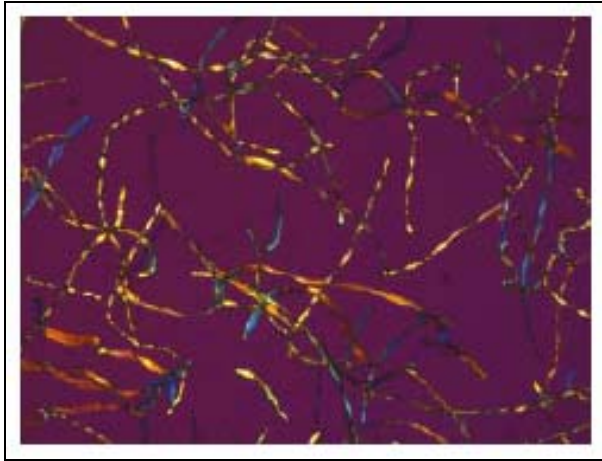
Marketing plans were largely determined between BSC and CSIRO in conversations on a monthly basis about where BSC or CSIRO would be travelling and with who they would be meeting, e.g. information on Cottonscope was presented to all Cottonspec partner mills in China during a visit in December 2010.

**Table II – Development schedule**

Development Schedule			
Tasks	Start Date	Duration (Weeks)	End Date
Research and Hand Over	17-Nov-08	1	24-Nov-08
Study existing analysis software			
Software Stage 1			
Develop a basic user interface (UI)	17-Nov-08	2	1-Dec-08
Interface with hardware devices such as control board and camera			
Software Stage 2			
Convert SiroMat software to c++	1-Dec-08	5	5-Jan-09
Develop analysis code			
Software Stage 3			
Resolve technical issues from testing	5-Jan-09	4	2-Feb-09
Refine UI			
Hardware Design and Development	1-Dec-08	8	26-Jan-09
Testing	29-Dec-08	3	19-Jan-09
Analysis and Outcome	19-Jan-09	1	26-Jan-09
Marketing	26-Jan-09	ongoing	

CSIRO received the first BSC Siromat prototype for testing in the second half of 2009 at which time BSC Electronics had changed the instrument's name to the more commercially-oriented Cottonscope name. This first prototype followed almost exactly the SiroMat technology utilizing crossed polars and retardation plate to affect the interference colours used to identify fibre maturity. Figure 1 shows the image produced by this first instrument. Test results on this prototype were assessed at CSIRO against the 104 ITC cottons and other reference cottons, e.g. USDA calibration cottons for HVI.

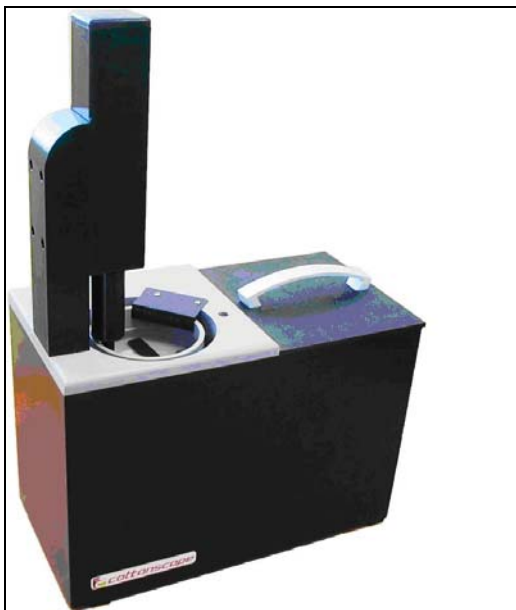
The new Cottonscope instrument with initial test results were presented in a paper to the Beltwide Cotton Conferences in January 2010 (see paper 2). At the conference, meetings were held with researchers from Bremen University, Texas Tech University and the USDA SRRC in New Orleans. After these meetings it became apparent to BSC (and CSIRO) that a fineness measure would be a beneficial addition to the Cottonscope instrument.



**Figure 1 – Cottonscope image showing mature (yellow) and immature (orange and blue) fibre snippets (1 mm)**

BSC commenced work to include Cottonscan immediately after the Beltwide Conferences of 2010 and the combined instrument was introduced at the Bremen ICCTM meetings in March 2010 and as a poster at the Bremen International Cotton Conference (see poster 4).

The new combined Cottonscope instrument includes a small water bowl with a stirrer within which the camera tube and lens capture 1 mm snippets circulating randomly across the field of view (see Figure 2).



**Figure 2 – Image showing Cottonscope with Cottonscan and SiroMat technology**

Snippets in the water are illuminated by two coloured LEDs (red and green), which are combined and transmitted through a polarizer through the water medium. A second crossed polarizer and retardation plate are not included in the new combined instrument, so the colours assumed by ‘mature’ fibres in this instrument are not represented by the interference phenomenon used in SiroMat and the first Cottonscope prototype. According to BSC this eliminates a source of error associated with the use of the second polarizer and retardation plate, which had been identified previously by CSIRO. The photo in Figure 3 shows the image produced by the combined instrument.



**Figure 3 – Combined Cottonscope image showing mature (red) and immature (dark) fibre snippets (1 mm)**

The combined instrument now provides direct measures average linear density as well as maturity and maturity distribution and ribbon width and ribbon width distribution in the specimen. It completes measurement of these properties (on 20,000 x 1 mm fibre snippets) in 30 seconds.

The combined Cottonscope was exhibited by BSC at the 2010 Shanghai ITMA (see Figure 4), where it received a range of enquiries from mill representatives in Turkey, Germany and China. Following this ITMA, Cottonscope was extended to ACSA, Australian cotton growers, Chinese mills and US researchers. In September 2011, the Cottonscope will be exhibited at the Barcelona ITMA.



**Figure 4 – Mr Mark Brims (LHS) with his daughter and friend at the BSC Electronics Booth showing Cottonscope, the fineness and maturity instrument that utilizes the CRDC/CRC/CSIRO SiroMat and Cottonscan technologies at the 2010 Shanghai ITMA**

A list of presentations made by BSC and CSIRO throughout the project is listed under *Extension Opportunities*.

### ***Results and Outcomes***

Testing of the instrument has continued both at CSIRO and at Texas Tech University. The testing has revealed new relationships between Cottonscope measured data and fibre cross-section data from the Texas Tech cottons, which result in improved agreements between Cottonscope measures of fineness and maturity and reference values.

Specifically testing of the combined instrument by Dr Eric Hequet at Texas Tech and subsequently by CSIRO revealed improved correlations with reference data after the

Cottonscope maturity value had been corrected using the ribbon width measurement for fibre diameter (perimeter) and the original maturity value (measured without crossed polars) as a measure of Micronaire. Previous correlations between Cottonscope maturity and reference values of maturity had never exceeded 85%. The correlation with the new corrected Cottonscope maturity value and reference values now exceeds 95%. Correlations of fineness values did not change.

A large and extensive comparison of Cottonscope data with Texas Tech cross-section data, FMT and AFIS data is currently underway. Test data are being compared on the basis of comparisons with cross-section reference data and their fulfilment of accepted theoretical and empirical relationships between fibre cross-section geometry and Micronaire. The resulting paper will provide a key, peer review assessment on the performance of these maturity and fineness tests for other researchers and users of the technology.

Testing has also revealed the test error associated with specimen preparation, e.g. cored 2 mm snippets result in higher errors of prediction than 1 mm guillotined snippets. Further work is required to improve the specimen preparation technique in terms of sample and preparation time and to link the test to higher volume test methods, i.e. to the HVI.

At the time of writing five Cottonscope instruments have been bought or are being used on approval before buying. Cottonscope instruments are located at CMSE Belmont, CPI Narrabri, the USDA ARS SRRC New Orleans LA, Texas Tech University Lubbock TX and Dai Chung Textiles Ltd., Guangdong (owned by Central Textiles Hong Kong).

The European agents of BSC Electronics are showing Cottonscope at their booth at the Barcelona ITMA September 21<sup>st</sup> – 28<sup>th</sup> 2011.

Cottonscope is also a finalist in two science/engineering competitions; it is one of three finalists in the Eureka ANSTO ‘Innovative Use of Technology’ category to be announced on September 6<sup>th</sup> 2011 and is a finalist in two categories (‘Research and Development’ and ‘Innovations and Inventions’ categories) for the NSW Engineering Excellence Awards to be announced on September 16<sup>th</sup> 2011.

### ***Conclusion***

The Cottonscope technology has been successfully transferred to BSC Electronics and into their company Cottonscope P/L. Comparison of Cottonscope test results with reference cross-section test data show good, clear relationships. To date Cottonscope instruments are located at CMSE Belmont, CPI Narrabri, the USDA ARS SRRC New Orleans LA, Texas Tech University Lubbock TX and Dai Chung Textiles Ltd., Guangdong (owned by Central Textiles Hong Kong).

The next two years will be important in terms of extending and marketing the instrument, and testing iterations expected in the software, sample preparation procedures and linkages with other test instruments, e.g. HVI, and quality prediction systems, e.g. Cottonspec.

In September 2011 agents of BSC Electronics will exhibit Cottonscope at the Barcelona ITMA. In February 2012, the instrument will be displayed by CSIRO at the Australian Cotton Seminar in Chongqing, China. To this end, CSIRO have submitted a PRP to the CRDC for funding to support Cottonscope in 2012/13.

### ***Extension Opportunities***

During the course of this project a second license for Cottonscan was incorporated into Cottonscope. The new instrument combining the maturity (SiroMat) and fineness

(Cottonscan) instruments was revealed at the Bremen International Cotton Conference in March 2010 and subsequently exhibited at the Shanghai ITMA in June 2010.

During the course of this project presentations on Cottonscope were given to:

- Cottonspec partner mills, Shandong and Chongqing, China, June 2009
- Cotton Collective meetings, Narrabri, Australia, August 2009
- Cottonspec partner mills, Shijiazhuang, Chongqing, Beijing, Anhui, Shandong and Jiangsu, China, December 2009
- Beltwide Cotton Conferences, New Orleans LA, USA, January 2010
- Bremen International Cotton Conference, Germany, March 2010
- ACSA, Sydney, Australia, May 2010
- ITMA (Asia), Shanghai, China, June 2010
- Australian Cotton Conference, Gold Coast, Australia, August 2010
- CCC CRC Science Forum, Narrabri, Australia, October 2010
- Cottonspec partner mills, Chongqing, Shandong, Guangzhou and Hong Kong, China, December 2010
- Beltwide Cotton Conferences, Atlanta GA, USA, January 2011
- ACSA, Sydney, Australia, March 2011

In June 2011 a discussion paper on Cottonscope and its advantages was written and accepted for publication in the Australian Cottongrower (for the Australian market), Textile Asia (for English-speaking Asia) and Melliand Textilberichte (for English speaking Europe).

### **Publications**

#### **Refereed (peer review)**

1. Abbott, A. M., Hequet, E. F., Higgerson, G. J., Lucas, S. R., Naylor, G. R. S., Purmalis, M. M and Thibodeaux, D. P., (2011), Performance of the Cottonscan instrument for measuring the average fiber linear density (fineness) of cotton lint samples, *Textile Res. J.*, **81**, 94-100

#### **Conference papers**

2. Brims, M. and Hwang. H., (2010), Introducing Cottonscope: A rapid and precise measurement of cotton fibre maturity based on SiroMat, National Cotton Council, *Beltwide Cotton Conference proceed.*, New Orleans LA, USA
3. Naylor, G. R. S., Gordon, S. G., Brims, M. and Hwang, H., (2011), Cottonscope – Rapid, independent and simultaneous measurement of both cotton fiber linear density (fineness) and maturity, National Cotton Council, *Beltwide Cotton Conference proceed.*, Atlanta GA, USA

#### **Conference posters**

4. Brims, M. and Hwang. H., (2010), Introducing Cottonscope: A rapid and precise measurement of cotton fibre maturity based on SiroMat, Bremen International Cotton Conference, March 2010 Bremen Germany

#### **Other (industry journals/magazines)**

5. Long, R. L., Bange, M., Gordon, S. G. and Constable, G., Measuring the maturity of developing cotton fibres, *Australian Cottongrower*, Oct-Nov 2010
6. Naylor, G. R. S., Yang, S., Gordon, S. G., Brims, M. and Hwang, H., Cottonscope: Advantages in measuring cotton fibre fineness and maturity separately, *Australian Cottongrower*, June-July 2011 (in print)
7. Naylor, G. R. S., Yang, S., Gordon, S. G., Brims, M. and Hwang, H., Cottonscope: Advantages in measuring cotton fibre fineness and maturity separately, *Textile Asia*, 27-29, July 2011

8. Naylor, G. R. S., Yang, S., Gordon, S. G., Brims, M. and Hwang, H., Cottonscope: Advantages in measuring cotton fibre fineness and maturity separately, Melliand International, Sep-Oct 2011 (accepted for publication)

*Awards*

- Eureka ANSTO 'Innovative use of Technology' Award finalist (one of three) – 2011
- Finalist in the NSW Engineering Excellence Awards 'Research and Development' and Innovation and Invention' – 2011

## *Part 4 – Final Report Executive Summary*

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