Cotton Catchment Communities CRC

FINAL REPORT

(due within 3 months on completion of project)

Part 1 - Summary Details

Cotton CRC Project Number: **4.03.01**

Project Title:

Identification of the Glass Transition Behaviour of Australia Cotton

Project Commencement Date: 01/06/07 **Project Completion Date:** 31/03/08

Cotton CRC Program: The Adoption

Part 2 – Contact Details

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

Background

The glass transition (Tg) in synthetic polymers is well known and is of critical importance to the processing and performance of products. This transition affects the mechanical properties of materials (including fibres) significantly, i.e., at temperatures below the Tg a material is hard and glassy and above the Tg the material is soft and rubbery. On the other hand the glass transition temperature in natural polymers is not so well-known but has now been well established for natural wool fibres providing valuable insight to processing and product performance. Many properties of wool products have been linked to the presence of the glass transition, e.g., felting shrinkage, wrinkling, stability of knitwear appearance; resulting in new processes with reduced energy usage and improved product performance. Tg has been measured in cellulosic sugars but there is little reported data in the literature on cotton, particularly the effect of moisture.

By developing a technique to measure Tg of cotton fibres that can be linked to the amorphous content in the fibre and to the mechanical properties further refinement of cotton breeding processes may be possible to control the ratio of crystalline to amorphous material in the fibre to optimise fibre processing and product performance. Processing of fibres involves significant mechanical action and the response of fibres to the stresses and strains involved are influenced by the fibre stiffness. In principle a softer and more flexible fibre may absorb the impact of the mechanical action and be less damaged. This would be expected to show up as less fly and nep in cotton sliver and a longer staple length. If the technical analysis of the material properties leads to specifications for ginning that are commercially viable, conditioning techniques could be applied to the gin to control the fibre material properties.

Objectives

1. List the project objectives and the extent to which these have been achieved.

Obj No.	Objective	No.	Milestone	No.	Performance Indicator
1	To determine the dependence of the cotton glass transition temperature on the moisture content	1.1	Evaluate DSC as a suitable method to measure the glass transition in cotton	1.1	Several cotton samples were examined by DSC to ascertain the suitability of DSC for measuring the Tg in cotton. The signal to noise ratio was high but after baseline subtraction a weak transition could be detected at about 50°C. A few different cotton samples (scoured and unscoured) and conditions (carrier oil, sub-ambient start) were tried.
		1.2	To identify and appoint a PhD student	1.2	Prof George Simon, head of Materials Engineering at Monash University was approached and agreed to collaborate with us on this project and act as the students university supervisor. The PhD scholarship was advertised in Oct 07 on the CSIRO and Cotton CRC websites as well as in SEEK and also JASON (Joint Academic Scholarships On-line Network). We had two candidates respond and they were interviewed however neither was deemed to be suitable. The scholarship was re-advertised in Feb 08, attracting 6 expressions of interest however none of the applicants had permanent residency in Australia. In the absence of a suitable candidate the decision was taken to close the project
		1.3	Measure the dependence of the cotton glass transition on moisture content.	1.3	n/a
2	To assess fibre properties related to Tg and to ginning conditions	2.1	Assess the use of Tg to predict fibre mechanical performance	2.1	n/a
		2.2	Measure the response time for moisture sorption in upland cotton	2.2	n/a
3	To show the effect of the fibre moisture content on the ginning characteristics	3.1	Trials completed to simulate the effect of the fibre properties on ginning performance	3.1	n/a
4	To show that Tg can identify differences between different cotton fibre varieties and maturities	4.1	DCS measurements provide a means to distinguish between fibre varieties and fibre maturities	4.1	n/a

Methods

The proposed methodology was as below. Given that the project never really got started there were no discoveries in methods that may benefit other related research.

The project will initially evaluate the use of DSC and other techniques to measure the Tg in cotton using standard upland fibres. The first stage of the project will develop a protocol for the measurement of the Tg with a major focus on the sample preparation and measurement conditions. The influence of these factors will be evaluated and a recommended procedure developed using fibres conditioned at standard conditions. This protocol will be used to measure the Tg of the upland cotton conditioned to a range of moisture contents by exposure to air at different humidity. A model will be investigated to relate the relationship between Tg and moisture content to the percentage of the amorphous component. This will provide a basis for the application of the technique to compare cottons of different genetic background and fibres with different maturity. A successful outcome at this point would provide an ideal opportunity to introduce a new scientist into the area of fibre mechanical properties, preferably a MSc or PhD student.

The next phase of the project will involve the measurement of the sorption characteristics of the cotton fibres to determine the response time for moisture sorption for comparison with commercial processing speeds. The fibre mechanical properties will also be measured as a function of moisture content to assess the effect of the amorphous component on the mechanical properties and to assess if the Tg provides a clear indicator of mechanical performance. These studies will lead on to a simulated study of ginning using laboratory equipment and also an expanded study of other cotton fibre varieties and fibres with different specifications. The latter study will concentrate on fibres with a range of maturities due to the known relationship between crystallinity and maturity and the effect of maturity on the formation and presence of neps in sliver and white spots in fabric. The approach to the study is outlined in the following.

Measurement of Tg in cotton

- Develop method
- Develop techniques of measurements
- Model development
- Milestone #1

Measure effect of moisture content on Tg

- Cotton isotherm measurements
- Model development
- Milestone #2
- Prepare publication

Effect of related fibre properties

- Response time for moisture sorption
- Fibre properties
- Effect on ginning conditions defined
- Milestone #3

Simulate ginning behaviour

- Run trials on model gin system

- Milestone #4

Compare different cottons (maturity/types)

- Compare cottons of different maturity
- Compare upland/pima/other cottons
- Prepare publication
- Milestone #5

Results

No results to speak of

Outcomes

No outcomes

Conclusion

No conclusions

Extension Opportunities

n/a

Publications

n/a

Part 4 – Final Report Executive Summary

The project remains interesting if a suitable student could be found