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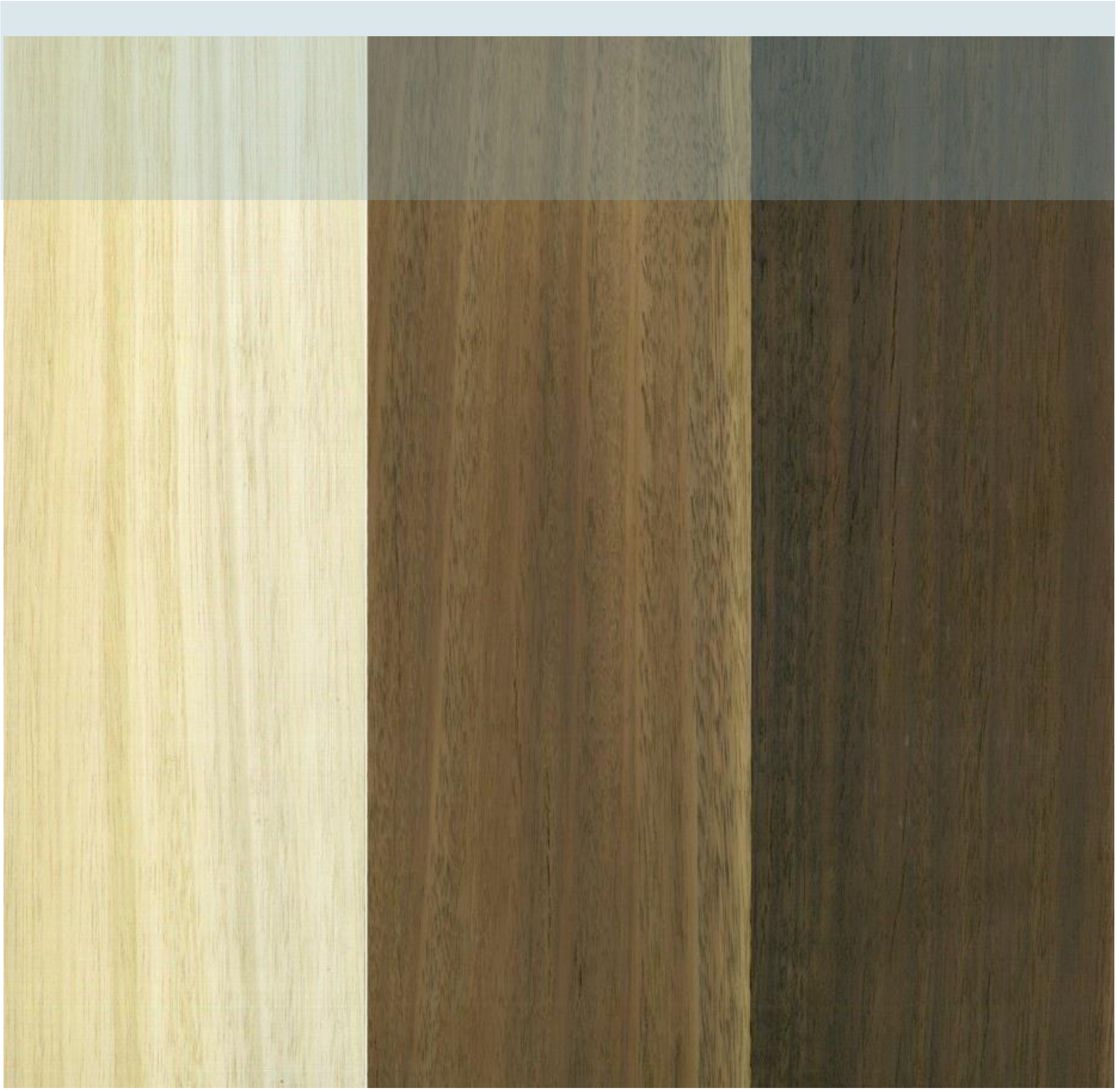
# Scion's core funded experiments on thermal modification of *Eucalyptus nitens*.

Report to the Speciality Wood Products research partnership



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## REPORT INFORMATION SHEET

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| ***REPORT TITLE*** | REPORT TO THE SPECIALITY WOOD PRODUCTS RESEARCH PARTNERSHIP ON SCION'S CORE FUNDED EXPERIMENTS ON THERMAL MODIFICATION OF *EUCALYPTUS NITENS*. |
| ***AUTHORS*** | ROSIE SARGENT, ELIZABETH DUNNINGHAM SCION |
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## INTRODUCTION

*Eucalyptus nitens* (Deane et Maiden) Maiden is a common plantation species in New Zealand, but is not well utilised as a sawn timber species, due to difficulties in processing. The value obtained for *E. nitens* logs is comparatively low – it is generally sold for pulp or for firewood. *E. nitens* does not have especially good dimensional stability, is non-durable, and is a pale, uneven colour, making it less desirable than many high-value tropical hardwoods.

Thermal modification involves heating wood to high temperatures (>180°C) in the absence of oxygen to alter the chemistry of the wood, and consequently alter the wood properties. Compared to other wood modifications, thermal modification is relatively a low cost (only requiring a particular design of high temperature kiln) approach.

Thermal modification has been used to improve the dimensional stability, durability and colour of many wood species worldwide, including research on *Eucalyptus grandis*, *E. saligna* and *E. globulus*. Mininco in Chile have done trials thermally modifying *E. nitens*, but it is not known if this has been commercialised. The Finnish ThermoWood Association recommend schedules of 185°C (for dimensional stability) and 200°C (for durability) for thermal modification of hardwoods. Zanuncio, et al. (2014) modified *E. grandis* at several temperatures between 170°C to 230°C, which gave increasing dimensional stability with increasing temperature.

It is hoped that thermal modification can be used to similarly improve the value of *E. nitens*, through increased stability, and by achieving an even dark colour. While durability was not the main target of this research, increased durability was also possible with high temperatures.

## APPROACH

Laboratory scale trials were carried out on kiln dried *E. nitens*. This was sourced from Specialty Timber Solutions, and the trees originated from a farm forest in the North Canterbury area. Replication was thirty-nine boards, each cut into three end-matched 500mm long samples.

Using the lab-scale Scion thermal modification kiln, two modification schedules were used. With one schedule, the wood was heated to 185°C and held for 2 hours; with a second, the wood was heated to 210°C and held for 2 hours. A third schedule was to hold wood as an unheated control. No information could be found on durability of thermally modified eucalypts, so it was decided to use a temperature slightly higher than the ThermoWood Association recommendation, to ensure likelihood of a large difference in modification severity between the two schedules.

Changes in wood colour, shrinkage, durability and mechanical properties were assessed using standard methods. More specifically durability was assessed using an in-house screening test.

## RESULTS

### *Colour*

Thermal modification turned the light-coloured timber dark brown, with the 210°C modification giving a darker brown than the 185°C modification (Figures 1 & 2). After 7 months exposure to sunlight the modified boards faded to a similar colour to the controls, with the 210°C modified boards changing colour the most.

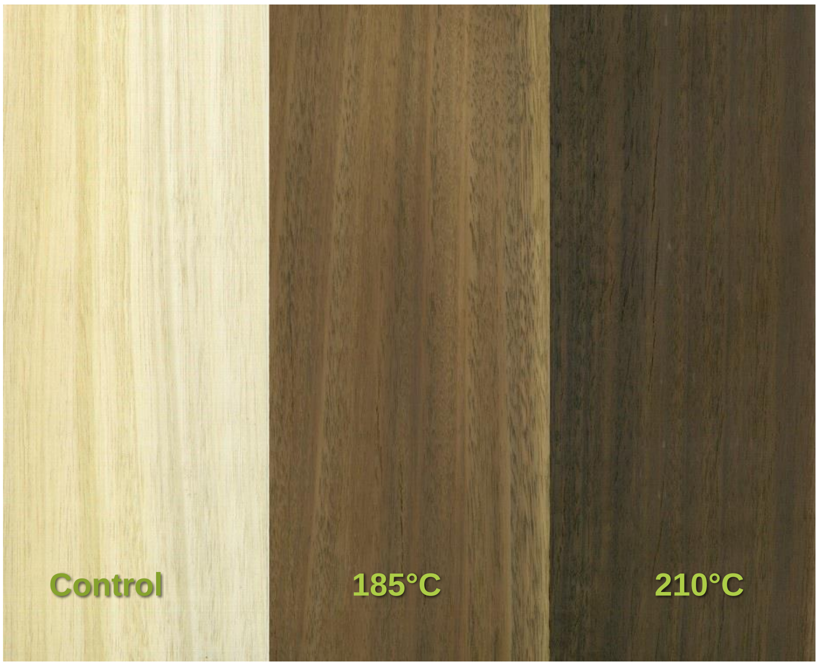


***Figure 1.*** *Comparison of the colours following each modification*

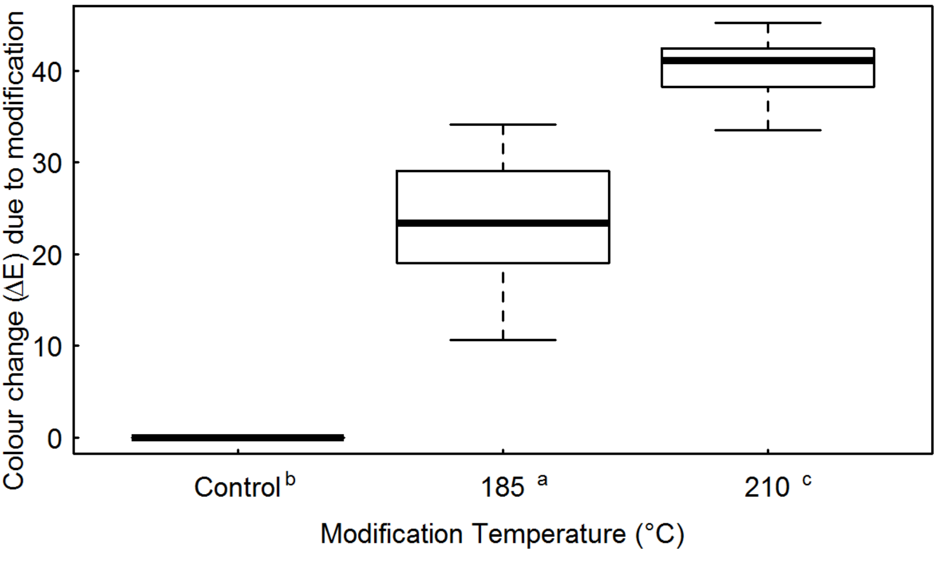


***Figure 2.*** *Change in colour (expressed as ΔE) between the unmodified controls and the modified boards. Superscript letters indicate treatments that are significantly different to each other (95% confidence level).*

Stability

Anti-shrink efficiency (ASE) is a measure of how much wood shrinks and swells when in contact with water. A higher ASE value indicates that the wood shrinks and swells less. ASE values are shown in Figure 4. The treated samples have higher ASE values than the controls, indicating that they have increased dimensional stability.

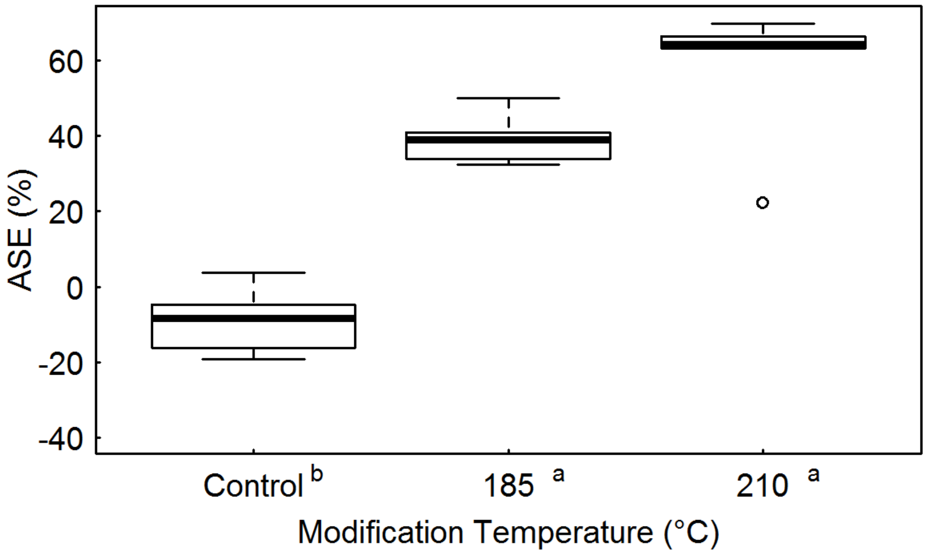


***Figure 4**. Anti-shrink efficiency (ASE) for each modification temperature. Superscript letters indicate treatments that are significantly different to each other (95% confidence level).*

## Mechanical Properties

Mechanical properties are shown in Table 1. MOE (stiffness) is not changed by the modification, but MOR (strength) is significantly reduced.

***Table 1:** Average Mechanical Properties for each schedule. Superscript letters indicate values that are significantly different (95% confidence).*

| | MOE [GPa] | | MOR [MPa] | |
|---|---|---|---|---|
| Schedule | mean | % loss | mean | % loss |
| Control | $12.4^{a}$ | - | $117.1^{b}$ | - |
| 185 | $12.7^{a}$ | -2 | $73.2^{c}$ | 38 |
| 210 | $11.2^{a}$ | 10 | $48.7^{c}$ | 58 |

## Durability

Table 2 shows the results from the Sutter durability screening tests. The mass loss of samples is determined from 8 fungal exposure tests, and samples pass or fail each test depending on the level of mass loss.

A treatment passing all 8 tests is likely to have improved durability. Samples thermally modified at 185°C showed similarly low durability to the unmodified controls, but is slightly better than the unmodified radiata pine. The *E. nitens* modified at 210°C showed a similar level of durability to radiata pine modified at 230°C, so it is interesting that the *E. nitens* has a similar level of durability from a lower modification temperature.

Radiata pine modified at 230°C has durability equivalent to H3.1 (i.e. suitable for cladding).

*Table 2.* Results of the durability screening test

| Treatment | No. tests passed |
|---|---|
| *E. nitens* Control | 2/8 |
| 185°C | 2/8 |
| 210°C | 6/8 |
| 230°C radiata pine | 6/8 |
| radiata pine Control | 0/8 |

## Conclusions

Thermal modification of *E. nitens* gives the wood a dark colour, which fades when exposed to direct sunlight. Thermal modification also gives improved dimensional stability and improved durability for the 210°C modification schedule. Thermal modification decreases the MOR (strength) of the wood.

## Acknowledgments

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Timber for this study was sourced from John Fairweather at Specialty Timber Solutions, Sefton, North Canterbury.

## References

Zanuncio, A. J. V., Motta, J. P., da Silveira, T. A., De Sá Farias, E., & Trugilho, P. F. (2014). Physical and colorimetric changes in *Eucalyptus grandis* wood after heat treatment. *BioResources, 9*(1), 293-302.