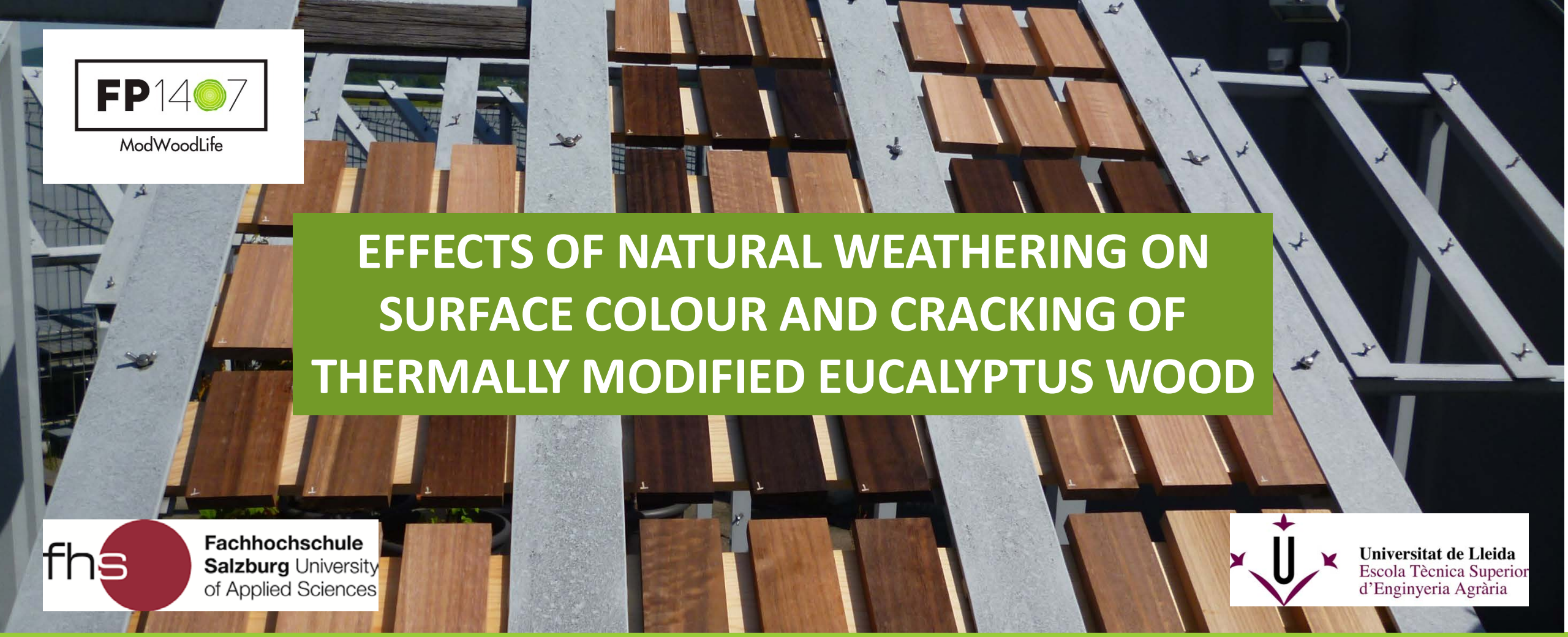

EFFECTS OF NATURAL WEATHERING ON SURFACE COLOUR AND CRACKING OF THERMALLY MODIFIED EUCALYPTUS WOOD

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Motivation

BEFORE

AFTER

Light exposure and natural weathering

Source: Touza Vázquez, 2012.

Motivation

Darkening of wood

Increased added-value

Source: www. tocadacotia.com

Source: Mold Rup System

Source: www.americanwoodworker.com

Minimize possible effects of natural weathering

Introduction

Research questions

1. Is Thermal modification improving the **colour stability** and/or the **surface cracking appearance** of the wood over the time?
2. **If so, which treatment temperature** leads to the smallest colour change and the best surface appearance in outdoor conditions?

The aim of the study

Quantify the **colour changes (ΔE*)** and **surface cracking:**

- Blue gum wood (*Eucalyptus globulus*)
- Thermal modification (140, 160, 180, 200, 220ºC)
- 12 months of outdoor exposure;
- Benchmarking unmodified against thermally modified samples
- Focus on the surface (just for aesthetic purposes);

Materials and Methods

Materials and Methods

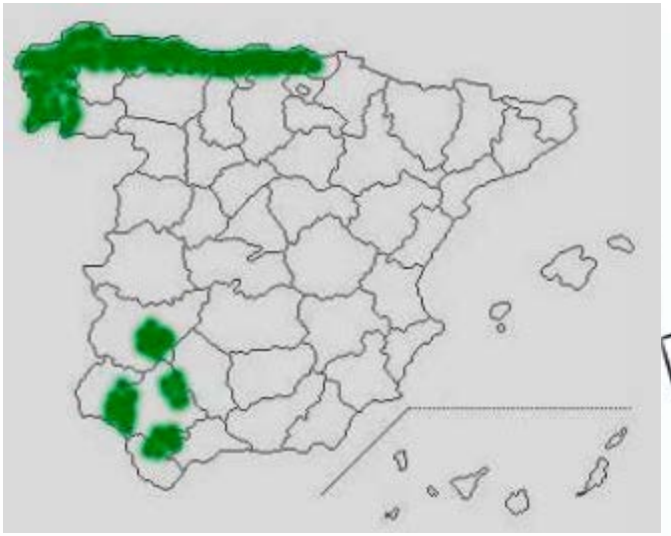
Blue gum Wood –

Eucalyptus globulus

Age of trees: 25 to 35 years-old

Density (12%): 650 to 900 Kg/m³

Renewable resource
Possibility to replace less sustainable products



Main specie planted in Spain

140 ˚C
160 ˚C
180 ˚C
200 ˚C
220 ˚C
(+ control)

Duration: 6h

CIELab
9 measurements per sample

UNE-EN 927-3
Duration: 1 year
From May 2015 to April 2016

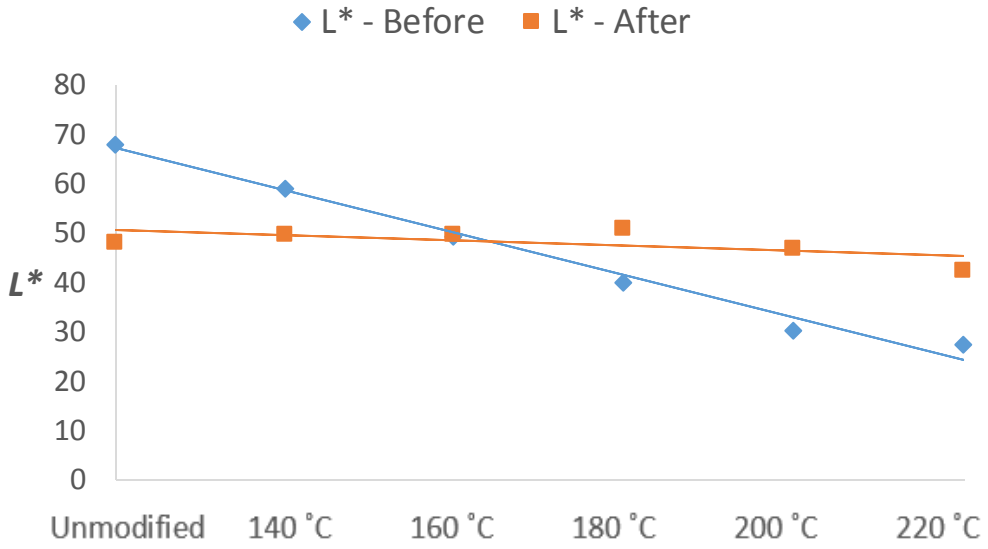
CIEDE2000

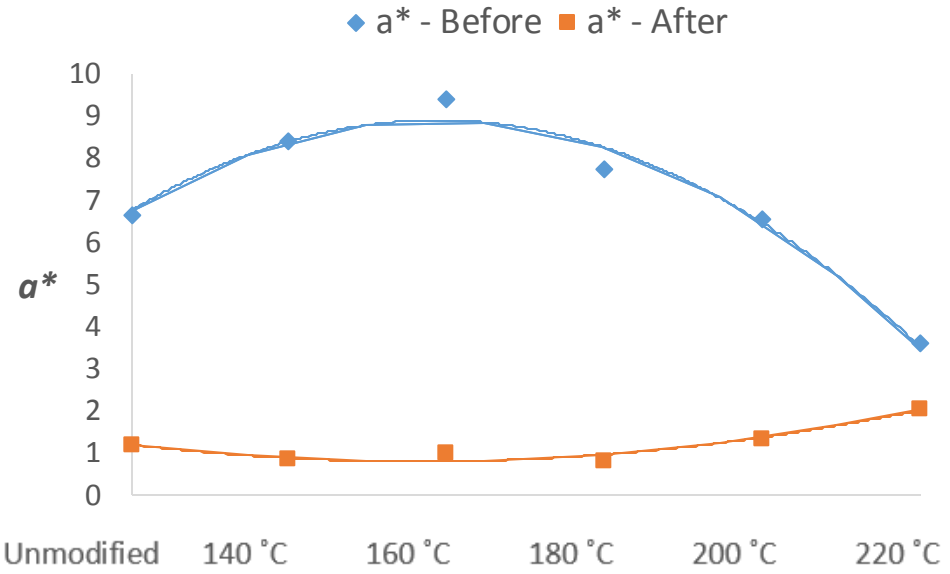
$$\Delta E_{00} = \sqrt{\left(\frac{\Delta L'}{k_L S_L}\right)^2 + \left(\frac{\Delta C'}{k_C S_C}\right)^2 + \left(\frac{\Delta H'}{k_H S_H}\right)^2 + R_T \left(\frac{\Delta C'}{k_C S_C}\right)\left(\frac{\Delta L'}{k_L S_L}\right)}$$

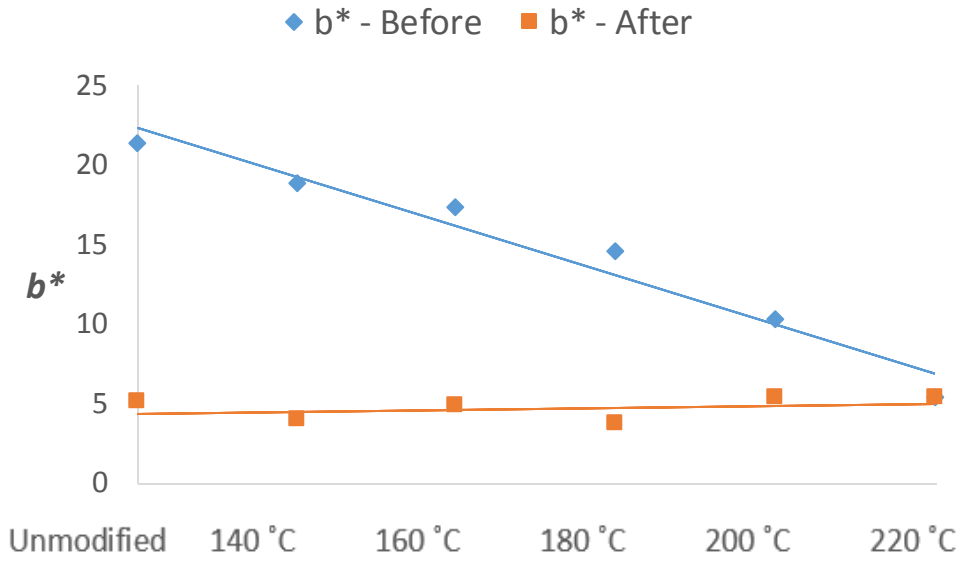
Results and discussion

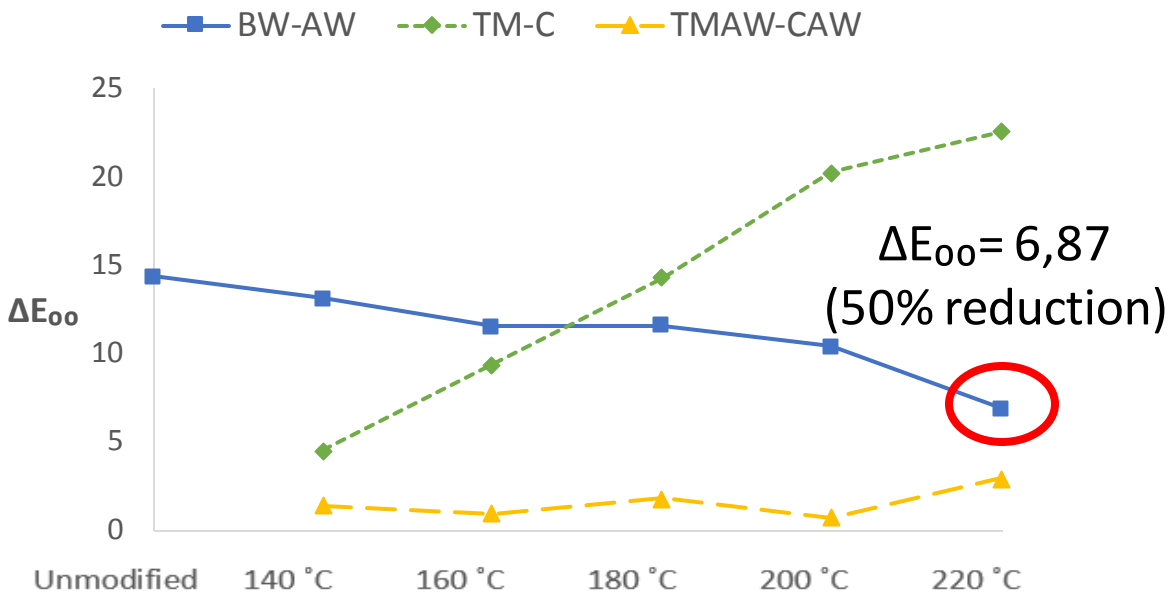
Y samples

	Control	140 ˚C	160 ˚C	180 ˚C	200 ˚C	220 ˚C
No natural weathering						
L=*	68,28 (3,63)	59,47 (3,92)	49,52 (3,56)	40,09 (4,77)	30,30 (2,77)	27,48 (2,54)
a*	6,68 (0,92)	8,40 (0,47)	9,40 (0,58)	7,73 (1,11)	6,57 (1,68)	3,62 (1,10)
b*	21,40 (1,63)	18,80 (1,82)	17,40 (2,16)	14,61 (3,61)	10,35 (3,15)	5,36 (1,95)
1 year of outdoor exposure						
L=*	48,31 (3,23)	50,12 (3,14)	50,03 (4,29)	50,97 (5,11)	46,95 (4,82)	42,71 (6,00)
a*	1,19 (0,31)	0,85 (0,40)	1,01 (0,43)	0,82 (0,34)	1,37 (0,44)	2,06 (0,53)
b*	5,12 (1,09)	3,96 (1,53)	4,90 (1,63)	3,81 (1,18)	5,33 (1,81)	5,41 (1,10)


L* - Before
L* - After
L*
80
70
60
50
40
30
20
10
0
Unmodified
140 ˚C
160 ˚C
180 ˚C
200 ˚C
220 ˚C


a* - Before
a* - After
a*
10
9
8
7
6
5
4
3
2
1
0
Unmodified
140 ˚C
160 ˚C
180 ˚C
200 ˚C
220 ˚C


b* - Before
b* - After
b*
25
20
15
10
5
0
Unmodified
140 ˚C
160 ˚C
180 ˚C
200 ˚C
220 ˚C


BW-AW
TM-C
TMAW-CAW
ΔEoo
25
20
15
10
5
0
Unmodified
140 ˚C
160 ˚C
180 ˚C
200 ˚C
220 ˚C
ΔEoo= 6,87
(50% reduction)

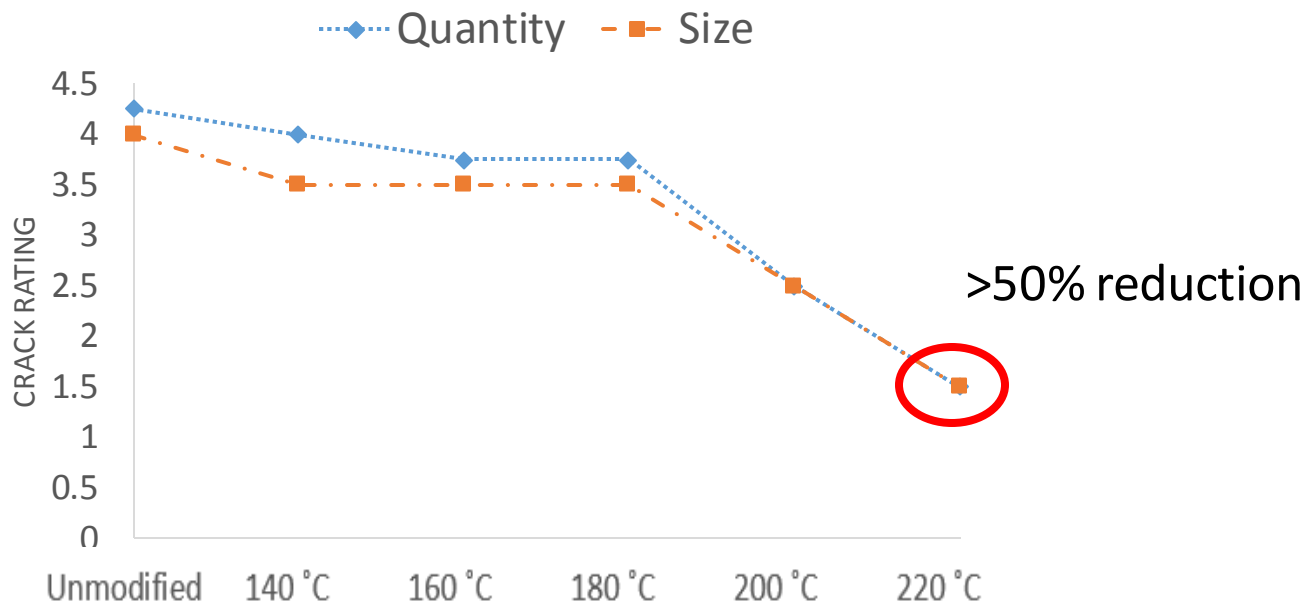
Surface cracking analysis

Rating	Quantity of cracks
0	None, i.e. no detectable cracks
1	Very few, i.e. small, barely significant number
2	Few, i.e. small but significant number of cracks
3	Moderate number of cracks
4	Considerable number of cracks
5	Dense pattern of cracks

DIN ISO 4628-4

Rating	Size of cracks
0	Not visible under x 10 magnification
1	Only visible under magnification up to x 10
2	Just visible with normal corrected vision
3	Clearly visible with normal corrected vision
4	Large cracks generally up to 1 mm wide
5	Very large cracks generally more than 1 mm wide

DIN ISO 4628-4



Control, 140-180 ˚C

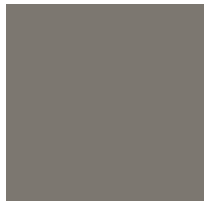
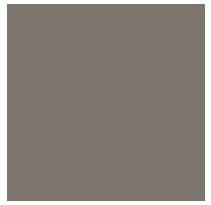
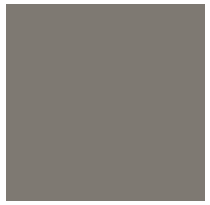
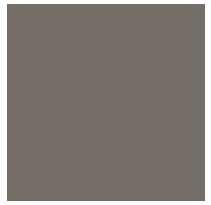
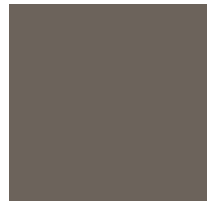
200 ˚C

220 ˚C

After 1 year of outdoor exposure

Surface cracking far greater in:

- control samples;
- 140 ˚C;
- 160 ˚C;
- 180 ˚C.

		Control	140 ˚C	160 ˚C	180 ˚C	200 ˚C	220 ˚C
No natural weathering	Colour data*						
	wood						
1 year of outdoor exposure	Colour data*						
	wood						
ΔE_{oo}=		14,38 (1,44)	13,11 (1,70)	11,52 (1,55)	11,58 (2,39)	10,38 (1,49)	6,87 (1,30)

*Source: http://www.easyrgb.com (Converts colour data to image).

Conclusion

1. Thermal modification can help to improve colour stability and surface appearance of wood samples exposed outdoor.
2. Thermally modified wood at 220 ˚C showed a more homogenous distribution of the colour and surface appearance presenting the smallest ΔE_{oo} (before x after weathering) of the experiment.

Next steps

1. Further explore the region of temperatures close to 220 ˚C, and apply different durations of TMT.

THANK YOU!

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