



Evaluation of heat treated black alder wood by FT-NIR

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Wood is a great material because:

- Is ecological/ sustainable/renewable/aesthetical
- Is energy efficient, traditional and modern
- but is not perfect....



Problems appear: related to moisture, UV stability, dimensional stability, resistance to fungi. How to solve them? Through modification processes applied to wood.

Wood material for modification by HT

- Pine, poplar, beech
- Fast growing species
- Easy to treat
- Large quantities

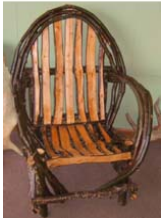
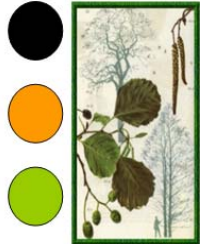
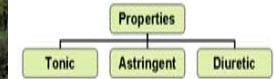


Objective

- The purpose of the present work was to evaluate the chemical changes occurred in wood (black alder) and veneers (black alder and hinoki) when exposed to heat treatment by using NIR method.
- CIELab system was added to complete the study with colour changes.

Black alder and hinoki

- In Romania quite little interest is shown to alder in spite of its potential.
- Few data regarding heat treated black alder may be found in the specialty literature.
- Modified wood is not very popular.
- Hinoki is one of the most valuable timber trees in Japan.
- Used for constructions, hot bathtubs, furniture and various interior work.
- Veneer is popular for table tennis blades



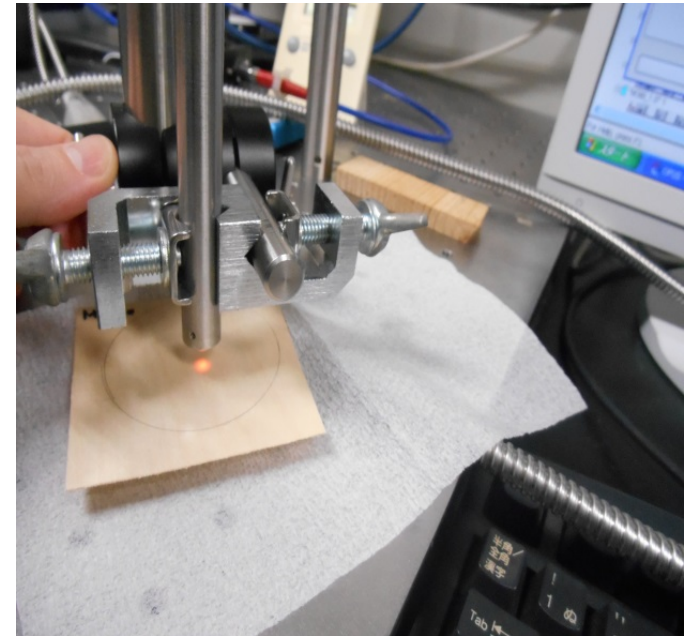
Material and method

- Black alder solid wood, 25 samples 70x70x16 mm (MC 8%)
 - two temperature levels of 120°C and 190°C for 3 and 6 hours were applied in a laboratory oven
- Hinoki and alder veneers, 24 samples 70x70x0.5mm (MC 7.5%)
 - HT was applied in a regular oven at 190°C for 10 and 40 minutes



NIR measurement

- A Matrix-F Bruker Optics spectrometer was used.
- Three measurements per sample were made.
- The correlation coefficients were calculated.
- Partial Least Squares regression analysis was used.
- Data were processed in Matlab R2014a.



Matrix-F Bruker Optics
spectrometer

Colour measurement

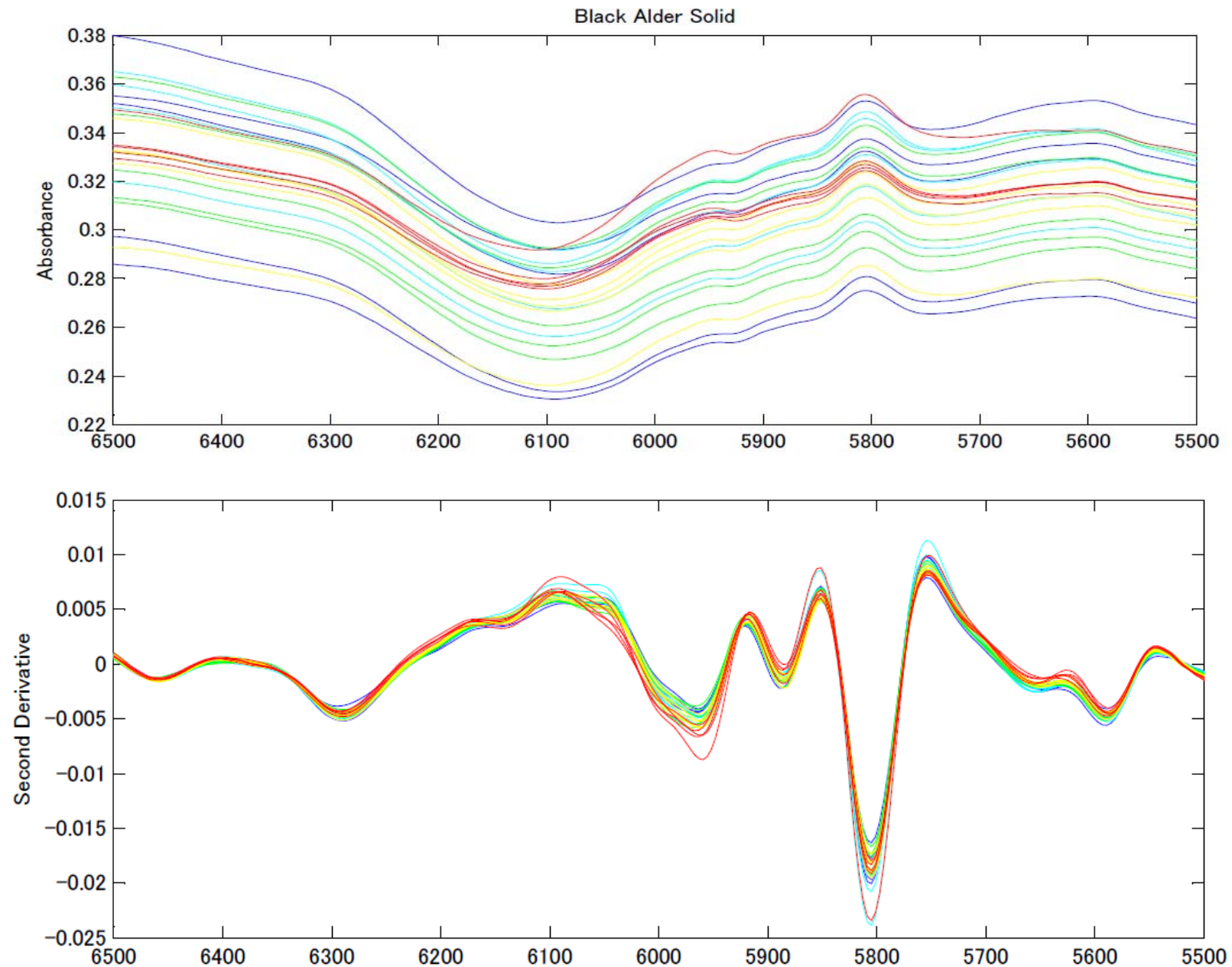


Chroma Meter
Konika Minolta CR 400

ISO 7724-2

- A Chroma Meter Konika Minolta CR-400 was used.
- Three measurements per sample were made.
- L^* , a^* and b^* colour coordinates were determined
- ΔL^* , Δa^* , Δb^* and ΔE^* were calculated.

NIR results for alder wood



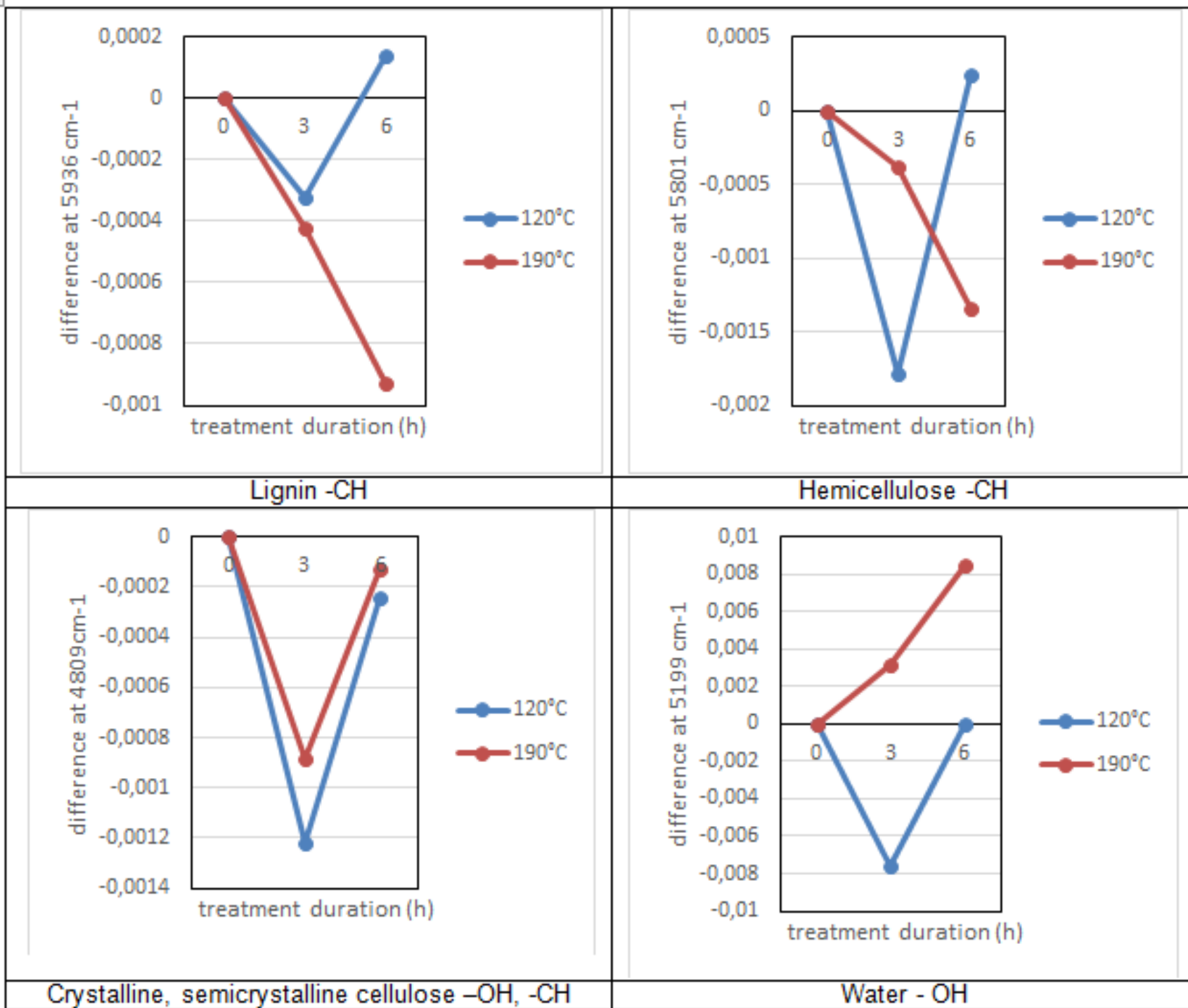
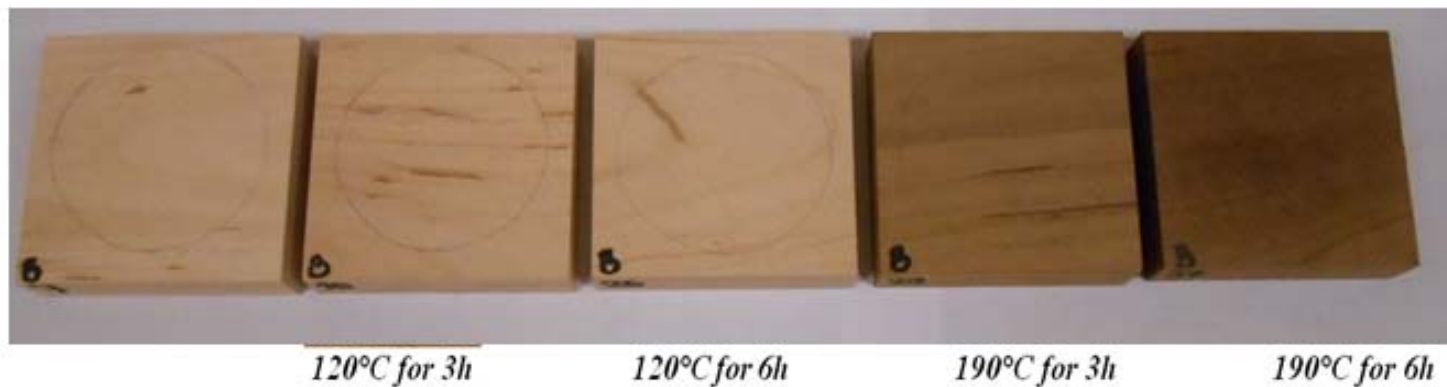
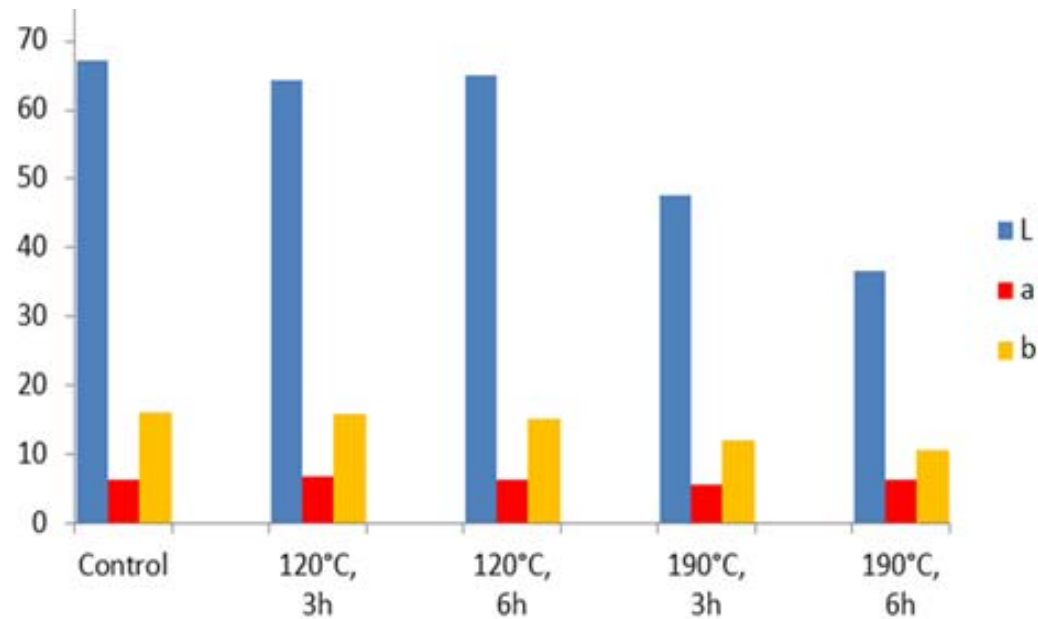
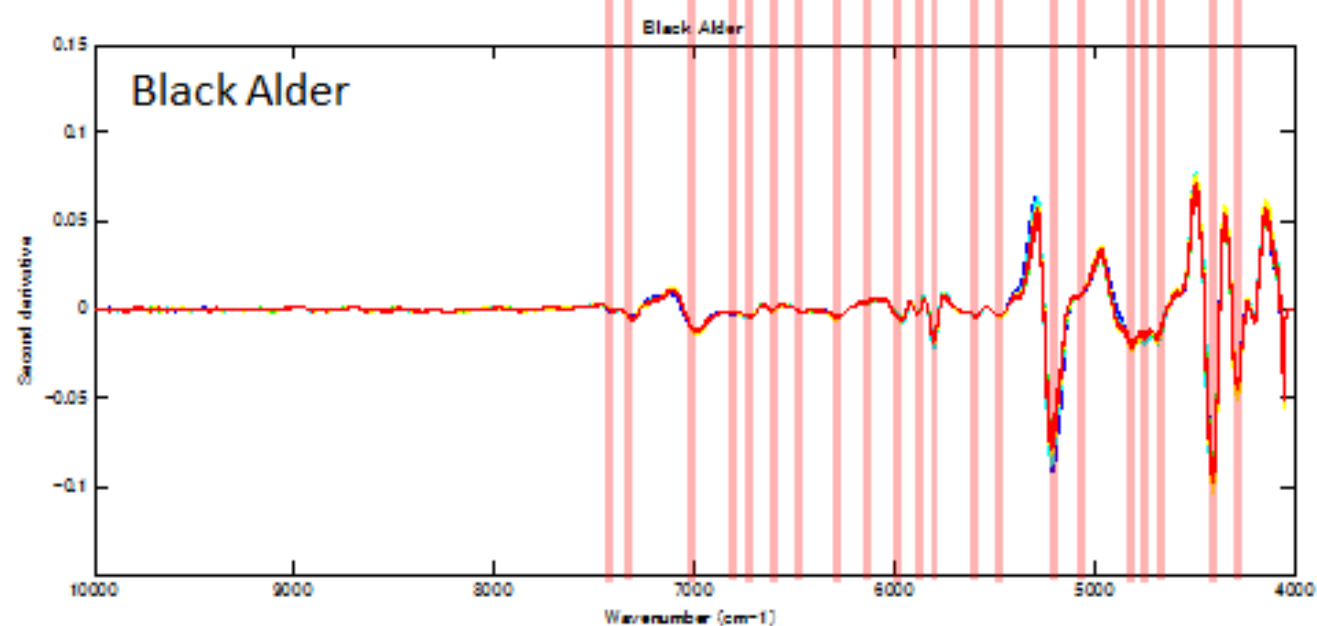
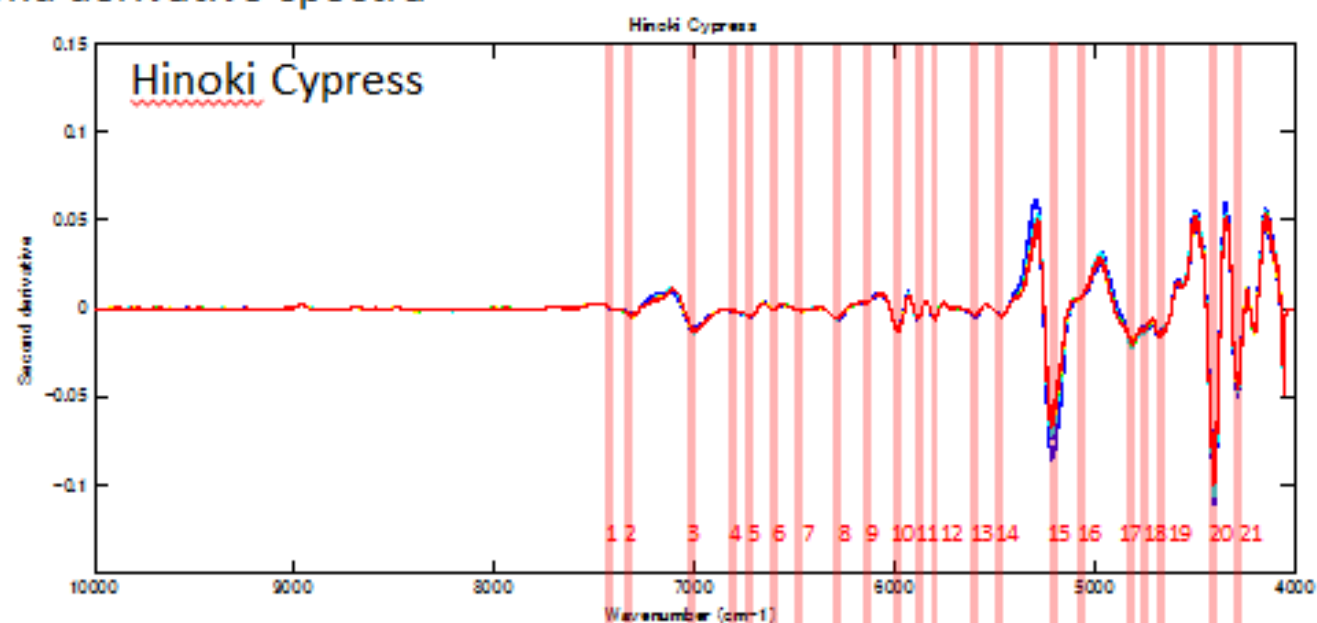


Figure 1. Changes of main chemical components of black alder as function of heat treatment

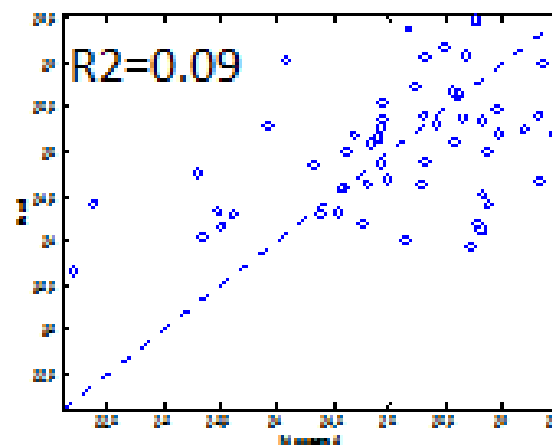
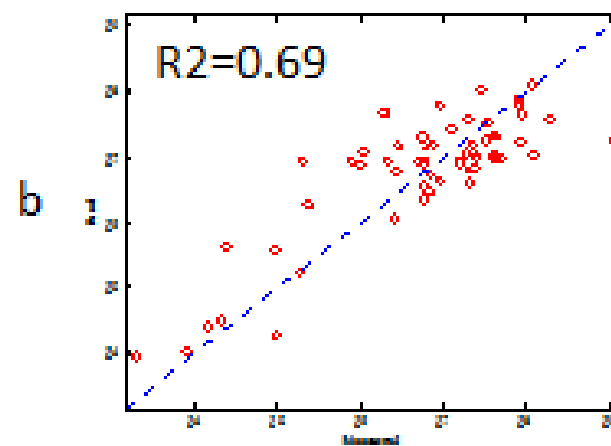
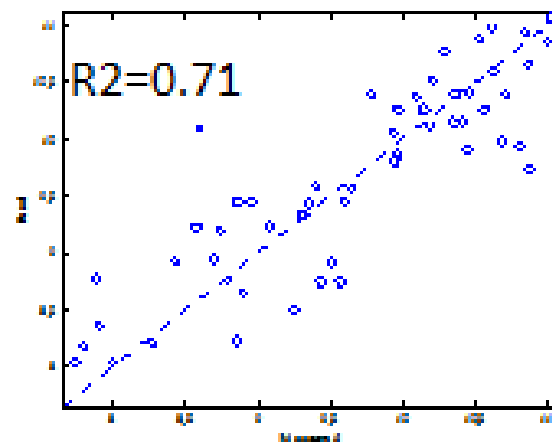
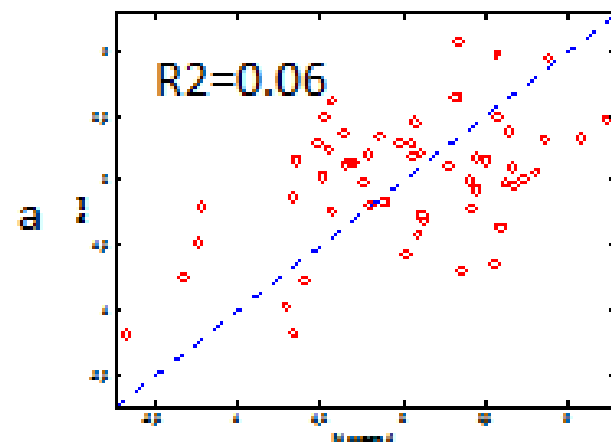
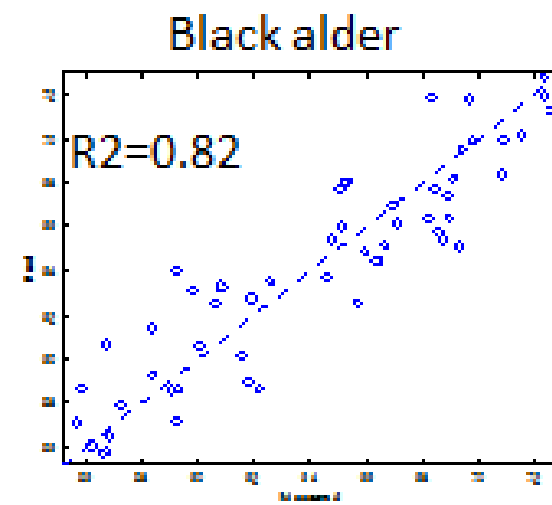
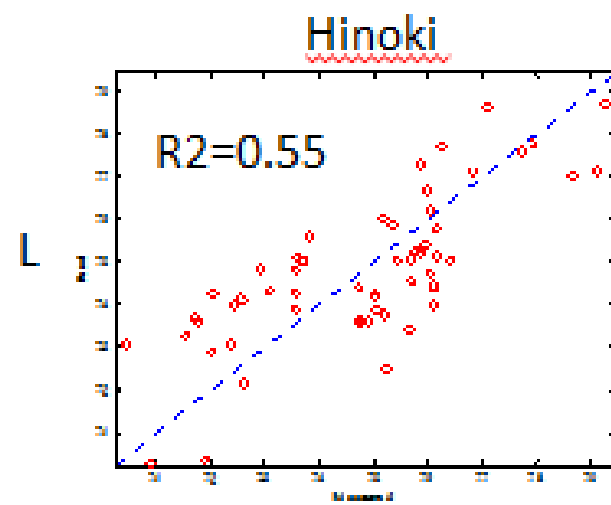
Results - colour of solid alder



Second derivative spectra

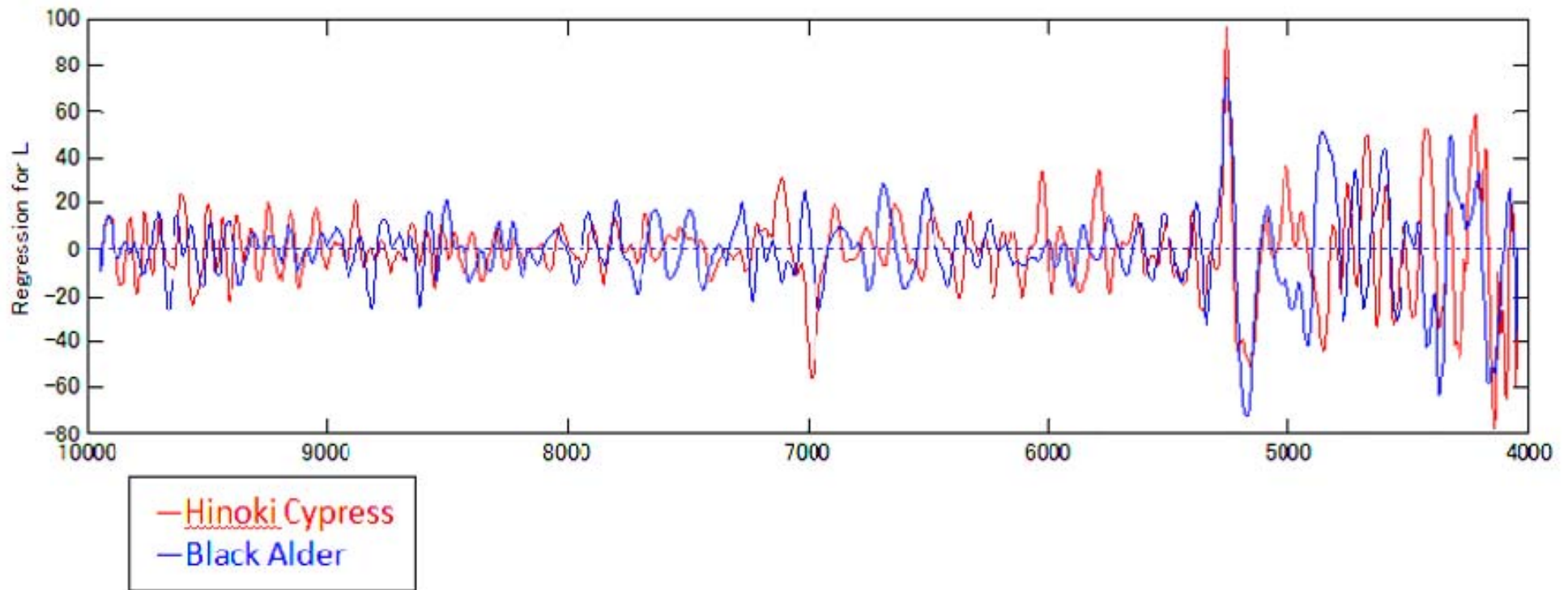


No	cm-1	nm	Remarks
1	7406	1350	Hemicellulose
2	7309	1368	Cellulose
3	7001	1428	Cellulose/H2O
4	6781	1475	Hemicellulose
5	6719	1488	Cellulose bounded
6	6600	1515	?
7	6445	1552	Crystalline cellulose
8	6295	1589	Cellulose
9	6125	1633	CH2
10	5979	1673	Lignin
11	5874	1702	Lignin
12	5797	1725	Hemicellulose
13	5593	1788	Crystalline cellulose
14	5466	1829	Cellulose
15	5211	1919	H2O
16	5064	1975	?
17	4806	2081	Cellulose
18	4744	2108	Cellulose
19	4675	2139	Hemicellulose
20	4401	2272	Lignin
21	4285	2334	Cellulose

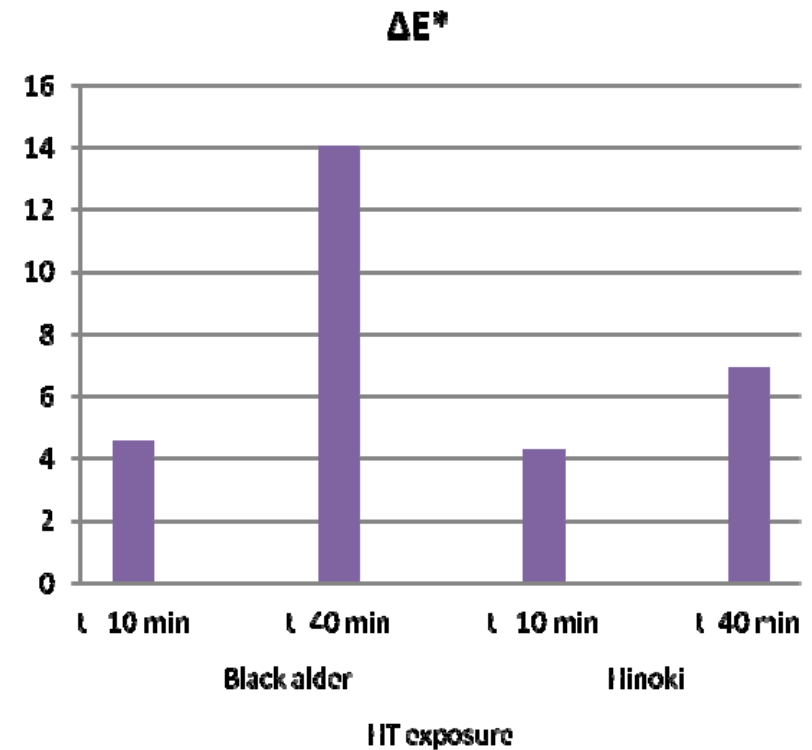
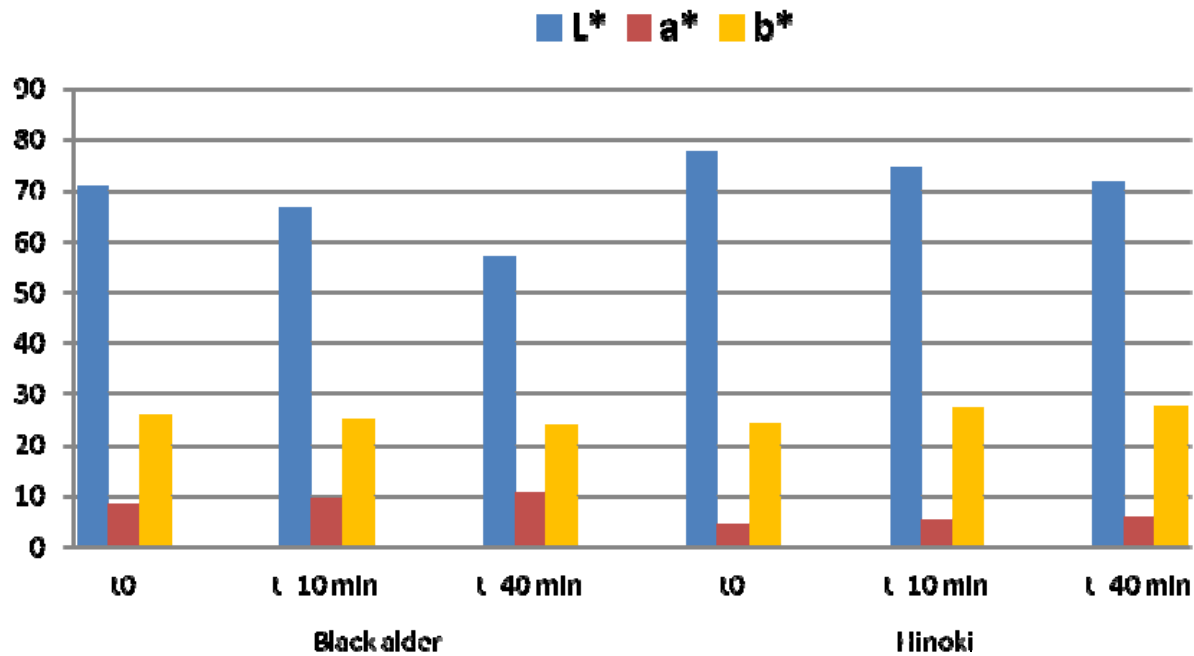


Regression coefficient for L*

- Lightness decreased as the heat exposure increased.
- One of the dominant factor for the prediction of L* was H₂O (band 7001cm⁻¹, band 5211cm⁻¹) and in case of hinoki, also hemicellulose at band 5797cm⁻¹



CIELab Results-veneers



Colour changes - veneers

Black alder		Hinoki	
			
Control	HT 190°C , 40 min	Control	HT 190°C, 40 min
L*=70,81(1,65) a*=8,42 (0,60) b*=25,78 (0,28)	L*=57,05 (1,16) a*=10,67 (0,23) b*=23,97 (1,04)	L*=77,64 (1,15) a*=4,37 (0,78) b*=24,18 (0,52)	L*=71,65 (0,64) a*=5,63 (0,26) b*=27,44 (0,34)

Conclusions

- It was found that heat treatment affected mostly the **hemicelluloses** as the exposure temperature and duration increased.
- Crystalline and semicrystalline **cellulose** were less influenced by heat treatment than amorphous regions of cellulose.
- A higher content of **lignin** in treated wood was noticed.
- Large spectral variation at absorptions due to **water** and **hemicellulose** were noticed.
- The changes in colour were caused mostly by the reduction in lightness which related to the degradation of hemicelluloses.
- Heat treatment applied to wood and veneers could enlarge their use for high value product.

Acknowledgements



Thank you for your attention!

