STSM Report

COST Action: FP1006

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Host: Thomas Schnabel, Fachhochschule Salzburg University of Applied Sciences

Period: from 10-4-2012 to 20-4-2012

Place: Kuchl (Austria)

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STSM topic: Quality control of thermally modified timber (TMT) with different in-line measurement techniques

Purpose of the visit

Thermo-treatment is a wood modification process that has gained importance in Europe in the last few years. One of the most interesting aspects of this process is the esthetical modification of the surface while maintaining or improving other properties of wood like durability.

In the frame of my PhD about Castanea sativa's wood I realized that thermal modification could be a way to research about decayed wood and for giving new uses to this mediterranean species. Fachhochschule Salzburg offered the possibility to test wood on a way I could not do it in my home institution taking advantage of the equipment on their laboratories in Kuchl.

Hence, the scientific mission would give me the chance to understand thermo-treatment techniques, learn how to work in advanced laboratory equipment, and learn about multivariate statistical analysis.

Description of the work

Materials and equipment

More than 150 test samples of sweet chestnut wood were brought from Catalonia (north-east spain). Their size was 20×20×30 mm. Two batches were analyzed, the first one was of normal wood, and the second one of slightly red (decayed) wood. To assess the evolution of wood versus temperature over time we used four types of analysis simultaneously: mass loss, NIR, colorimetry and temperature control. Due to the different geometry of the different types of sensors the samples were adapted specifically. The specimens used to control weight loss were not modifyed,

but we had to drill the other specimens to assemble the sensors properly. The diameter to fit the NIR sensor was 12 mm, the color sensor requires a drilling 6 mm diameter, and thermocouple cable a gap of 2.5 mm. All the holes were 12 mm deep (see Figure 1).

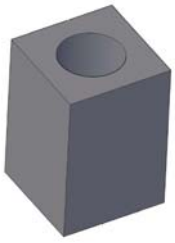

Figure 1. NIR test sample.

Figure 2. Drilling of the wood

Figure 3. Sample conditioning

The laboratory equipment used was the one the follows.

Table 1. Laboratory equipment used on thermotreatment

Equipment	Usage	Brand	Model
Forced convection drying oven	Drying and thermo-treatment	Binder	FD 53
Precision weighing Balance	Weight measure	Kern & Sohn	ABJ 220-4M
FT-NIR spectrophotometer	Measure of the NIR radiation inside the test sample	Bruker Optics	MPA
Reflectance colorimeter	Initial measure of the superficial colour of the test sample	Datacolor	Mercury
Fiber optic spectrometer	Continuous measure of the colour of the inner part of the test samples	GetSpec	2048-5-RM
Tungsten halogen light source		GetSpec	GetLight HAL-S
Data logger	Continuous measure of the temperature of the inner part of the test samples	TESTO	177-T4 Logger equipped with a thermocouple

Thermo-treatment process and modification measurement

The experiment was mainly designed to evaluate the degradation suffered by the european chestnut wood on a thermo-treatment. Prior to the start of the treatment the test samples were conditioned at 20ºC and 64% of humidity to ensure homogeneous wood conditions.

The normal and the slightly decayed wood were divided in two batches according to the temperatura applied: 185ºC i 200ºC. Higher temperatures were discarded because mechanical properties decrease seriously. The thermo-treatment was carried out in a oven for five hours under normal atmospheric conditions. The oxigen was not displaced or replaced. In-line measurements were done in order to control the process on real time for colour, NIR and temperature. The mass loss

was controlled on single test samples by extracting one each half an hour (See Table 2).

Table 2. Mass loss and in-line measurements for real time control

Measurements		Mass Loss	NIR	CIELAB	Temperature
5h cycle	Time among measures	30 min	2 min	15 s	15 s
	Total amount of measures	10	150	1200	1200

Moreover, the colour of the test samples was controlled before and after the process with a reflectance colorimeter to control the in-line process.

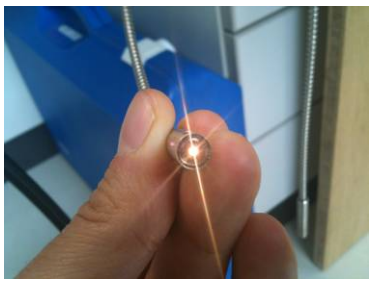

Figure 4. GetSpec in-line colorimeter sensor

Figure 5. NIR, colour and temperature control samples

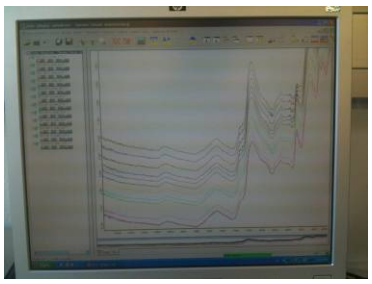

Figure 6. NIR spectra measured every two minutes

Statistical analysis

The results of the NIR were captured with the software Opus 5.5. and analyzed with the statistical package "The Unscrambler". To establish the relationship between the wood properties analyzed it were used multivariate techniques like principal component analysis. The colour analysis was carried out thanks to the CIELAB space transformation. Additionally, linear regressions and other statistical procedures were carried out.

Main results

NIR spectra absorbance increases as the wood looses mass during the thermo-treatment. Unfortunately, further investigation is needed to relate european chestnut wood with the peaks of the NIR spectra. However, NIR might be used to control the thermo-treatment of european chestnut.

Unfortunatelly the in-line colour measurement did not worked properly because wood shrinkage caused the sensor unstability. Experimental method improvement is needed to correct this issue.

Nevertheless, the reflectance colorimeter worked properly and it was found a relationship between the colour and the mass loss. R^2 was 0,6 up to 0,7 depending on the sample. It was also found that after the thermo-treatment the decayed wood could not be distinguished from the normal because both turned into the same colour.

Projected publications

The results achieved will be disseminated by publication in scientific journals and reported at the COST Action FP1006 meeting of autumn-winter 2012.

Future collaboration with the host institution

Future collaboration is expected with the Fachhochschule Salzburg in the frame of the COST Action FP1006.

References

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