Is it possible to detect thermal treatment of wood in low temperatures?

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According to ISPM-15 standard, all wood materials to be shipped should be heat treated in accordance with a specific time-temperature schedules that achieves a minimum wood core temperature of 56°C for a period of at least 30 minutes. The transformation of wood chemical structures depends on the treatment temperature and its duration (Esteves et al. 2009). Several papers report evidences that thermal treatments in temperatures above 120°C result in permanent changes in chemical wood structure (Tjeerdsma et al. 2005, Windeisen et al. 2007, Mehrotra et al. 2010). Not much scientific attention has been however dedicated for wood changes in moderate (50ºC – 150ºC) range of temperatures. No major modifications into principal chemical components of wood (lignin, cellulose, hemicellulose) are expected in wood exposed to low temperatures. Nevertheless, wood extractives (fatty acids, resin acids) and sugars might start its migration to the surface (Lambertz et al. (2010), Sandak et al. (2011)). An example of the PLS model for spruce (Picea abies) wood treated in temperatures from 40 to 100ºC is presented on Figure 1 (Sandak et al 2011). The model links near infrared spectra with reference values of know temperatures for the thermal treatment.

The goal of this work was to provide a scientific tool for verification of the wood thermal treatment according to ISPM-15 standard.

![Figure 1. PLS regression model of the wood treatment in low temperatures](image)
It is important to recognize that the temperature histories of various points located in the bulk of wood piece under thermal treatment are different, as shown in Figure 2. In consequence the outer part of the wood sample is exposed for higher temperatures in a longer period of time. In opposite, the core is exposed for lower temperatures and shorter time. Assuming that wood changes are proportional to the treatment temperature and exposition time, much more changes (to wood chemical/physic structure) are expected in the outer zone of the wood piece. It is schematically presented in Figure 3.

The question arises therefore, if is it possible to develop an original measurement protocol by combining all of the above statements? The proposed procedure starts with a calibration of the measurement system by means of series of laboratory-scale thermal treatments. The numerical model linking temperature changes and spectra variations is generated and validated by means of PLS algorithm. The unknown sample of wood to be verified is scanned in several points along the gradient of the piece thickness. The spectra are then used for estimation of the treatment temperatures. By mapping the estimated temperatures along the gradient it might be possible to estimate if the wood piece was thermally treated.

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References

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