The Potential of X-ray Tomography for Research on Modified Wood

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ABSTRACT

This paper exemplifies the use of X-ray tomography hardware and accompanying software for research on modified wood. Structural details on different spatial scales as well as time-dependent phenomena can be visualized, also including quantification of these structural details and probable changes due to treatment. As such, the impact of hydrophobing agents can be studied both structurally as well as regarding the efficacy of their water repellence effect, the anatomical changes of heat treated wood can be visualised and quantified at cell wall level as well as the density changes caused by these treatments, etc. X-ray tomography as such is the pre-eminent tool of the future for wood scientists in general and wood modification researchers more specifically.

1. INTRODUCTION

Modified wood is widely used in many different applications and has been a field of research for over a century, covering a large range of methods aiming at an improvement of wood properties. The broad range of possible modifications and modification techniques and their induced changes necessitate proper imaging and analysis to assess their impact. The changes of the basic wood characteristics such as strength, structure, chemical composition, etc., due to treatment, have to be mapped in order to optimise and control treatment level and efficacy. Obviously, the recent advances in X-ray tomography make it a very suitable research tool, especially enabling 3D visualization of the interior structure non-destructively before and after treatment.

2. EXPERIMENTAL

Nanowood is the highest resolution X-ray tomography scanner developed at UGCT, the Ghent University Centre for X-ray Tomography. It consists of an 8-axis system with two X-ray tubes and two X-ray detectors, specifically designed to obtain very high resolution scans as well as scans of larger objects. The system offers a large range of operation freedom, all combined in versatile acquisition routines (standard or fast scanning, tiling, helix, etc). It has a generic in-house developed CT scanner control software platform (Dierick et al. 2010) that allows full control of the scanner hardware. Reconstruction of the scans is performed with Octopus, a tomography reconstruction package for parallel and cone-beam geometry (Vlassenbroeck et al. 2007). A selection of samples were scanned in order to show the potential of X-ray tomography for investigating modified wood.

3. RESULTS AND DISCUSSION

Wood modification can be studied with X-ray tomography focussing on different aspects of the treatment: treatment level, dimensional stability, biological durability and wood anatomical changes. For this purpose both static as well as dynamic tomography can be applied. Static tomography and accompanying analysis has been used successfully to assess wood treated with hydrophobing agents. Similarly, structural changes induced by wood modification treatments, in particular related to thermally modified timber, can be studied accurately by scanning the samples before and after treatment. Especially the option to work at a resolution that allows analysing the cell wall interface with the modification agents and being able to assess this in 3D in relation to the wood anatomical pathways in different wood species related to their functional tissues is very rewarding. Microdensitometrical analysis is expected to reveal not only impact on the anatomical structure but has the potential to identify tissue related differences in altered wood density due to modification processes such as thermal treatment. Dynamic tomographical experiments can be performed e.g. to visualize water penetration in different kinds of wood materials treated with hydrophobing agents and assess their efficacy in either 2D or 3D. As such it can be used as an extended drop shape analysis tool too. Figure 1 exemplifies some of the possible experiments and analysis, ranging from microdensitometry, quantitative anatomy, water penetration visualisation and fungal pathway analysis.

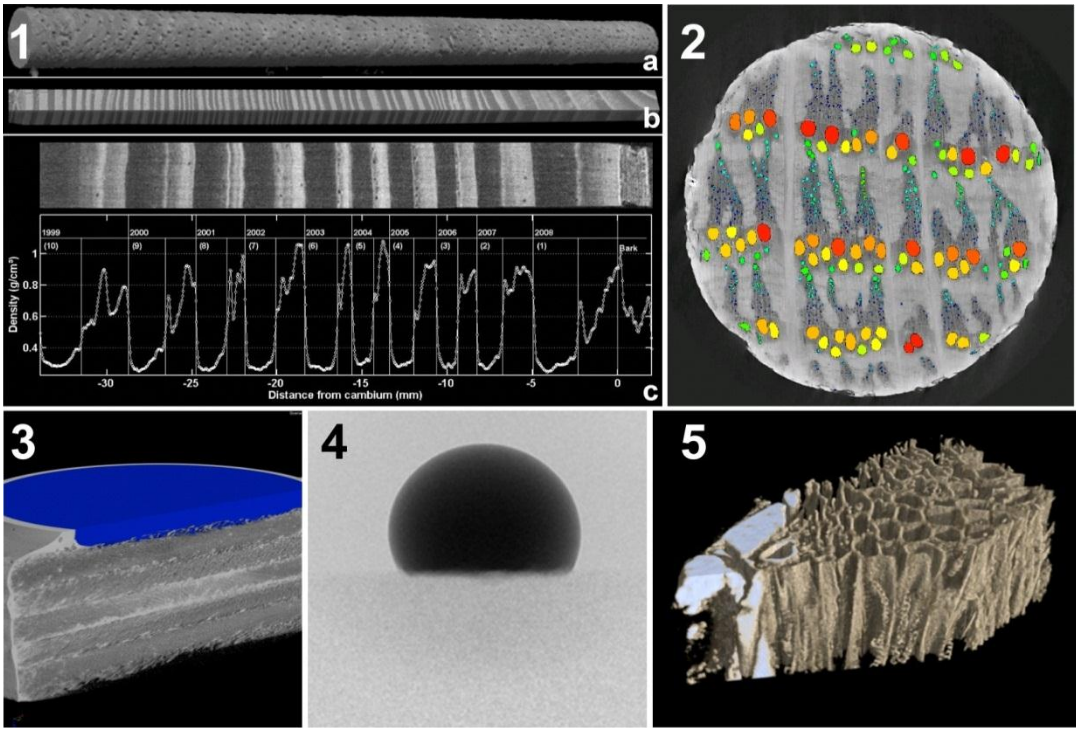

Figure 1: *(1) 3D scanning of limba (a) and Scots pine (b) drill core and the corresponding microdensitometrical profile of the Scots pine drill core with indication of ring width and age (c; for more information see De Ridder et al. 2011); (2) quantitative vessel analysis of oak; (3) 3D penetration of water in plywood (blue = water column on top of plywood, only penetration in first layer); (4) water droplet at t=0 on a MDF (Medium Density Fibreboard) panel; (5) high resolution CT scanning of fungal growth (Van den Bulcke et al. 2008)*

4. CONCLUSIONS

This paper briefly outlines the potential of X-ray tomography scanning and accompanying visualization and analysis for modified wood. Clearly, it is no longer only regarded as an advanced tool for imaging, but is used for quantitative research thanks to recent progress in both hard- and software. Its non-destructive character as well as potential to investigate time-dependent changes is very beneficial in the field of modified wood, assessing wood anatomical changes and moisture dynamical behaviour.

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