FACULTY OF BIOSCIENCE ENGINEERING

UGent WOODLAB

LABORATORY OF WOOD TECHNOLOGY (UGENT-WOODLAB)

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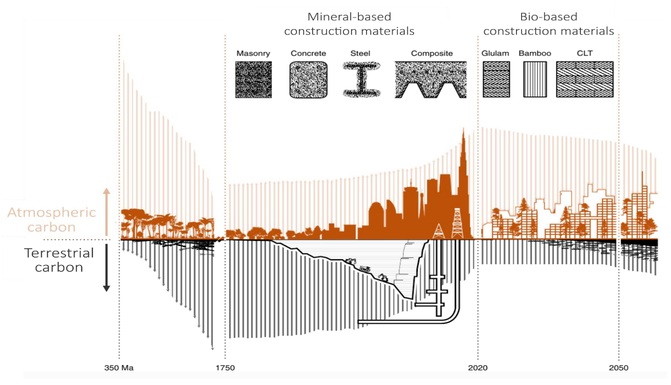
SERVICE LIFE OF (ENGINEERED) WOOD PRODUCTS AND BIO-BASED BUILDING MATERIALS



Processes responsible for formation, depletion and potential replenishment of land carbon pool, as well as changes in atmospheric CO_2 concentrations over time. Middle: urban and industrial growth depleted land-based carbon pools and increased atmospheric CO2 concentrations. Right: cities built from bio-based materials such as engineered timber and bamboo can serve as constructed carbon sinks. Ma, million years ago. Churkina et al. (2020).

Wood and other bio-based building materials are made from renewable resources and produced with considerably less energy and associated carbon emissions than many traditional building materials (concrete, steel). This makes them essential building elements in the much needed transition towards a more sustainable building industry. Many bio-based building materials are (to some extent) biodegradable, an excellent quality at the end of a material's service life as it solves waste issues, but a less desirable feature during use.

Left: Urbach tower, Germany. The curved timber components that give the tower its unique structure were designed and produced as flat panels that deform autonomously into predicted curved shapes when dried. © ICD/ITKE. Right: House with cork as exterior cladding © José Hevia

When an organic material is exposed to favourable moisture and temperature conditions as well as to degrading organisms, its functional and aesthetic service life can decrease. The risk of fungal decay depends on the environmental conditions and the material resistance.

A material's resistance to fungal decay depends on the material's natural durability and its hygroscopicity. Wood protection used to focus mainly on naturally durable wood species, often from tropical regions, or applying non-durable wood species that are treated with fungicidal wood preservatives. General awareness of the negative impact of biocidal products on the environment initiated a new way of thinking about wood protection. Other material characteristics that could extend service life, such as a material's moisture dynamics and structure, have been gaining importance. These are especially interesting when it comes to bio-based building materials, as there are many opportunities to alter material structure and moisture dynamics of engineered wood products and bio-based insulation materials.

Material characterization

To understand how different material characteristics (moisture dynamics, chemical composition and material structure) affect service life and fungal susceptibility, wood and bio-based materials need to be characterized. In that regard, I use various techniques and test methods:

- Moisture dynamics: LFNMR, DVS, Floating test, CMM
- Chemical composition: FTIR, paste test
- Material structure: X-ray CT

Fungal degradation

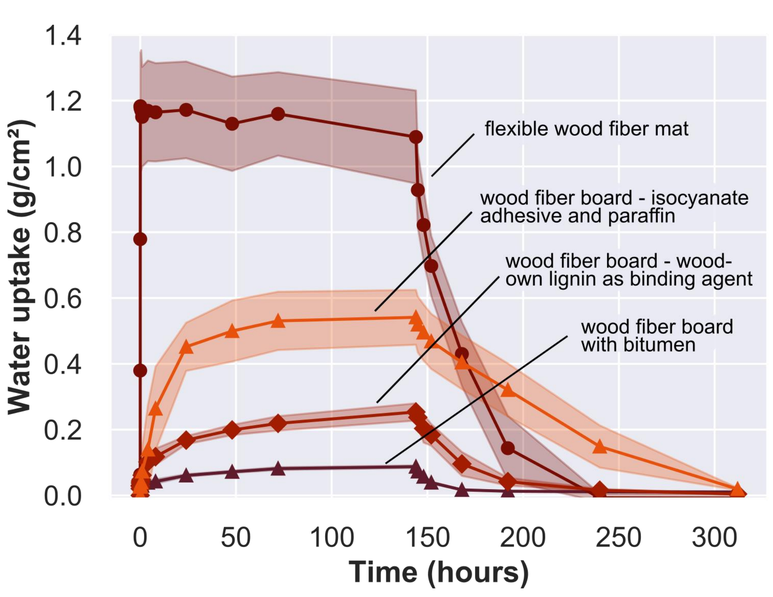
To determine how different material characteristics affect the decay risk of bio-based building materials, I have developed several methods to assess the influence of material chemistry, moisture dynamics and structure on fungal susceptibility:

- Semi-automated method for wood degradation monitoring using **X-ray CT**, to assess the influence of material structure and wood anatomy on fungal degradation
- A method with **MRI** to assess moisture production during the degradation process
- The **'paste test'**, to assesses the influence of material chemistry on fungal susceptibility of bio-based building materials.

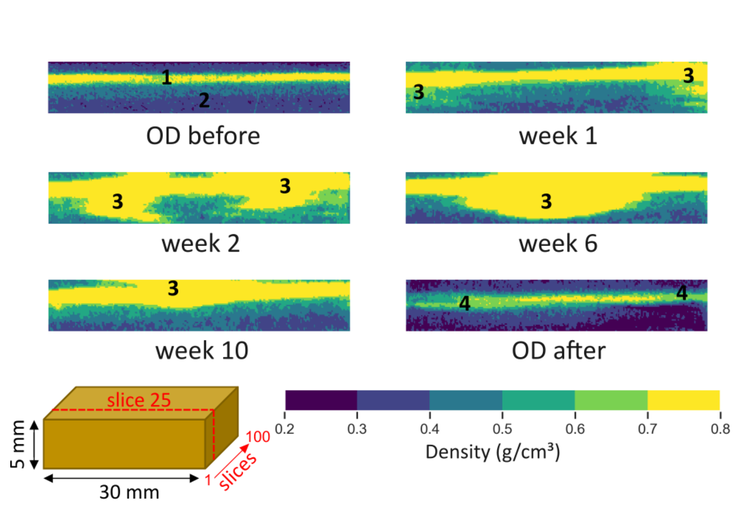
Fit-for-purpose design and application

Wood and wood products in general are known for being highly tailorable. Most efforts of tailoring wood and wood products are focused on optimizing mechanical properties, while a great potential for improving service life through material design remains unexplored. Why not take a similar approach when it comes to service life? My aim is two-fold:

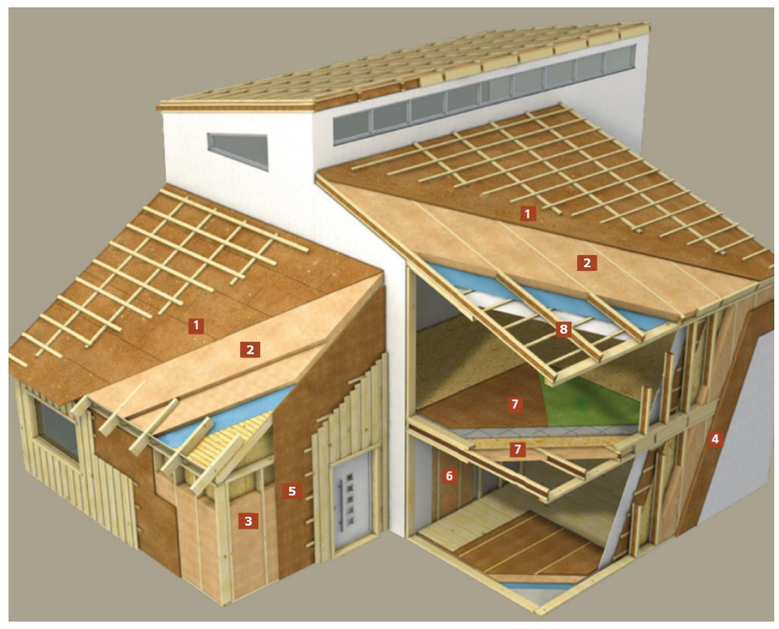
- investigate how smart material design can be used as a tool to extend service life of construction timber and engineered wood products.
- Design fit-for-purpose, hybrid bio-based materials, for various applications.



Mean liquid water uptake (g/cm²) with standard deviation over 144 h of absorption and 168 h of desorption in a floating test. Wood-fiber insulation boards made with fibers from the same origin had completely different moisture dynamics, depending on additives, adhesive and production process.



Density visualization (obtained through X-ray CT imaging) of slice 25 (located at approximately 2.5mm deep) of a Scots pine mini-block showing water production related to fungal activity (3). Water production (3) starts from the sides (week 1) and moves towards the middle of the mini-block (week 6). When comparing the oven-dry density profile after 10 weeks of degradation (OD after) with the oven-dry density profile before degradation (OD before), it can be observed that the density in the latewood (1) and earlywood (2) zones corresponding to the water production zones (3) at week 1 and 2 have been more severely degraded (4).



Left: Timber frame with wooden cladding. Right: Application of I-joists. Applications of bio-based insulation materials: 1) wind barrier, 2) insulation between rafters, 3) cavity insulation, 4) external wall insulation system, 5) wall insulation panels applied between exterior wall and cavity wall or cladding, 6) insulation of lightweight partition walls and 7) floor insulation. *Adapted from Dederich* et al. *(2019).*

About me

Postdoctoral researcher specialized in material characterization and fungal decay of wood and bio-based building materials. I started as a research assistant at UGent-Woodlab in 2016, after which I obtained an FWO SB grant for a PhD fellowship on the fungal susceptibility of bio-based building materials (2017-2021). After finishing my PhD, I moved to Denmark for one year for a postdoc position on modified wood products. Currently, I am working on an FWO junior postdoc grant (2022-2025) on game-changing designs for sustainable and affordable protection of mass timber products against fungal decay. I aim to have a positive impact and help to pave the way towards a more sustainable building industry.

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