# POLARIZED FT-IR STUDY OF CELL WALLS OF A HARDWOOD AND SOFTWOOD

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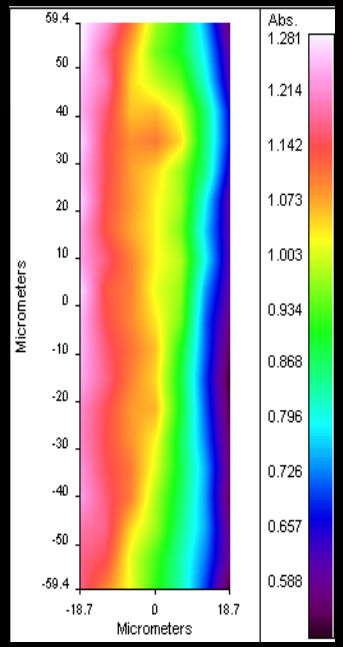
- Harwood: maple (Acer sp)
- Softwood:*Picea omorika* (Pančˇ) *Purkyne*
- Cell wall - a nano-composite in which cellulose, lignin and hemicelluloses are interconnected in a specific manner
- To follow the chemical variability and the orientation of cell wall polymers (cellulose, glucomannan, xylan and lignin), using imaging FT-IR microscopy, run in transmission mode and at different polarisation modes (from 0° to 90°).

Images taken through the light microscope in transmittance mode:

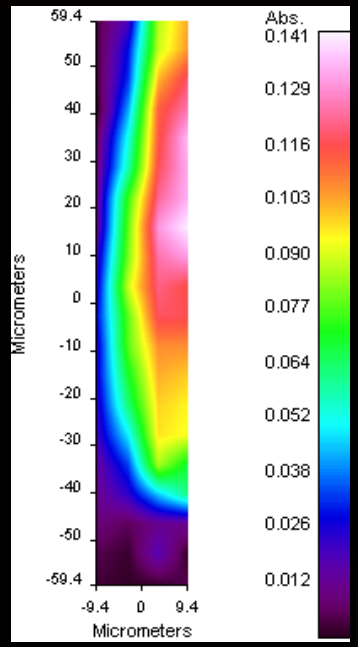
The sample seen trough FTIR imaging, set at 0◦ polarisation angle:

Omorika

Maple



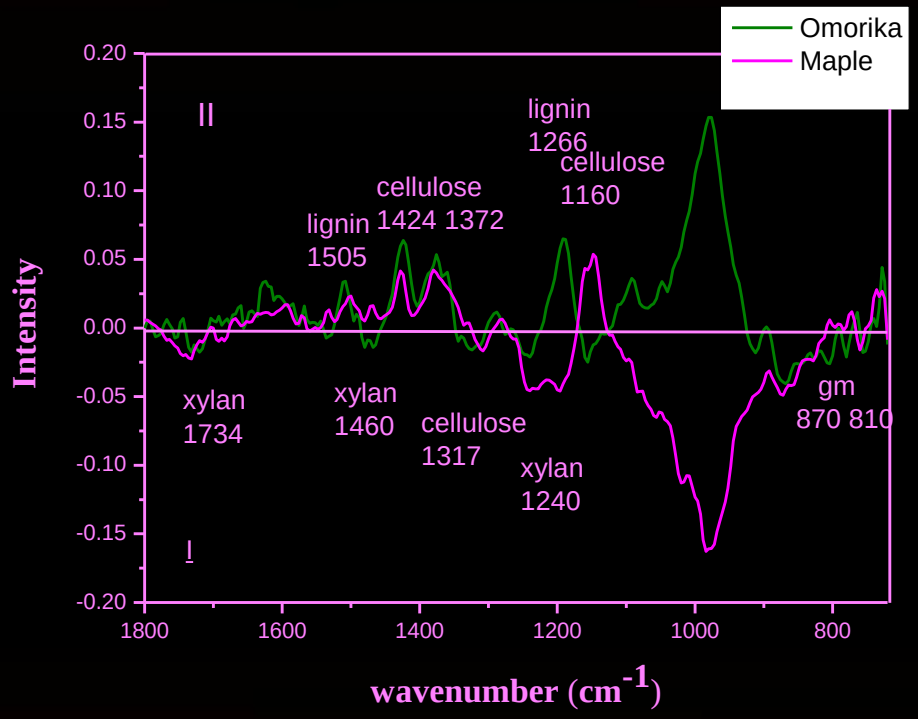

Omorika




Maple

$R = T_0^o / T_{90}^o$ ⟶

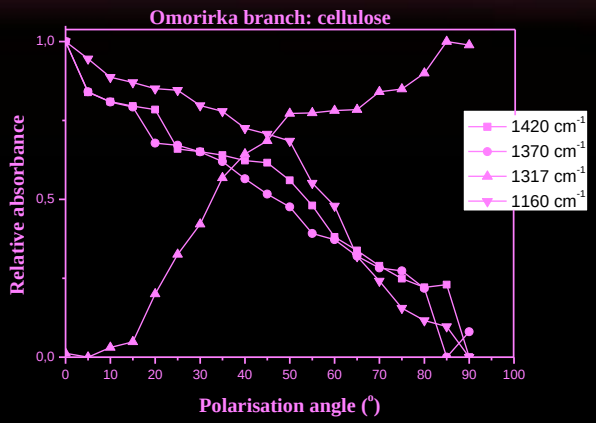
R ratio spectra,
$T_0o$ transmission spectra recorded at 0°
$T_{90}°$ transmission spectra recorded at 90°

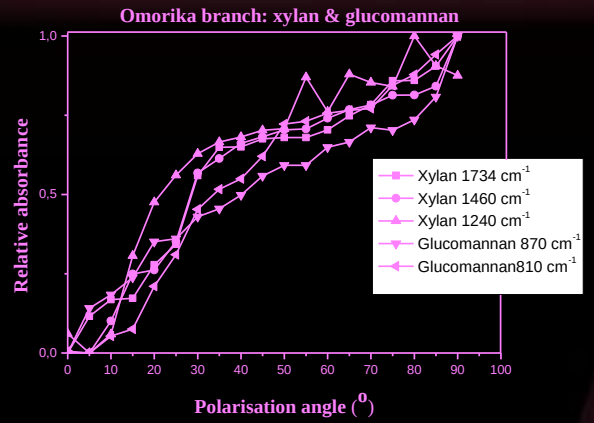


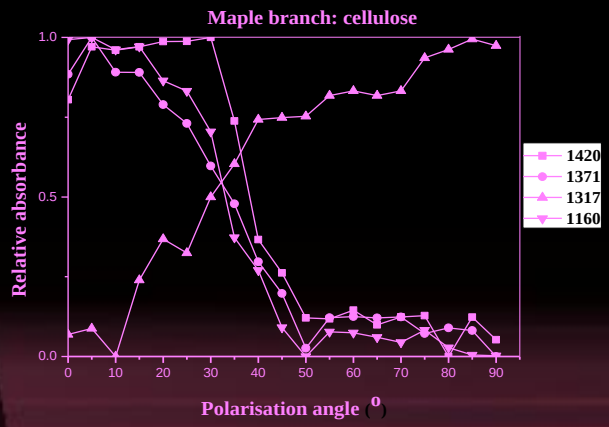

The average orientation spectra of maple and omorika branch cell wall

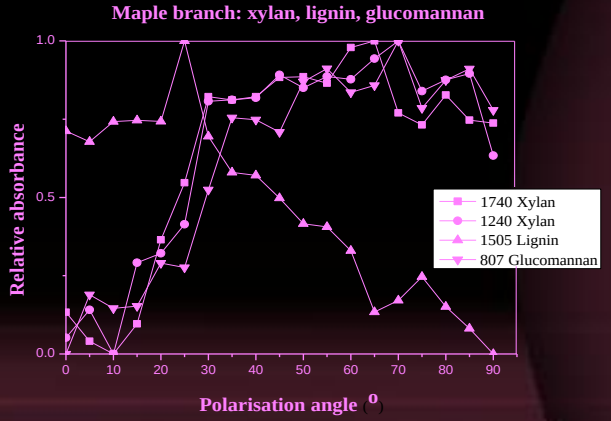
$$RA = (I_P - I_{min})/(I_{max} - I_{min})$$

RA is relative absorbance, $I_p$ is intensity of the absorbed IR radiation at a given angle of the polarisation, P, $I_{max}$ is the maximal intensity observed for a given vibration and $I_{min}$ is the minimal intensity observed for a given vibration.




The relative absorbance of IR specific absorption wavenumbers plotted against the polarisation angle for the different wood polymers for maple branch

- Tree vibration peaks of **cellulose**, the antisymetric C-O-C bridge stretching vibration at 1160 $cm^{-1}$, the C-H bending vibration at 1370 $cm^{-1}$ and the C-OH bending vibration of the $CH_2$-OH group at 1424 $cm^{-1}$ was found to be oriented parallel to the fibre axis. A cellulose vibration, the $CH_2$ wagging vibration at 1317 $cm^{-1}$ oriented perpendicular to the cellulose chain was also found.

- **Hemicelluloses** (**xylan-** vibrations at 1734 $cm^{-1}$, 1460 $cm^{-1}$, 1240 $cm^{-1}$, and **glucomannan**- vibration at 810 $cm^{-1}$) are parallel with the longitudinal axis of the isolated cell wall of maple and omorika. Absorption vibration of glucomannan was found at 870 $cm^{-1}$only in softwood sample.

- A **lignin** vibration, i.e. the C=C aromatic ring vibrations at 1505 $cm^{-1}$ showed a positive signal indication orientation of the lignin structure in parallel with the fibre axis, but G ring plus C=O stretching vibration at 1266 $cm^{-1}$ was found only in softwood sample.

- Both hemicelluloses are arranged in paralel with the cellulose microfibrils → components show anisotropic behaviour
- Lignin is also oriented parallel to the fibre axis in the cell wall.

# Thank you!