



Cell wall Characterisation of Reaction Wood by Confocal Raman Microscopy

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Objective:

Imaging and spectral characterisation of the cell wall layers in compression and tension wood based on Raman spectra acquired with a high lateral resolution

Introduction:

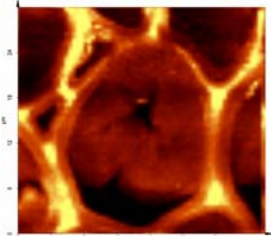
Raman microscopy allows to get information on the chemical composition on a microscale (400nm) and enables therefore to distinguish cell wall layers differing in their chemical composition and also to trace differences within single cell wall layers. For this preliminary investigations compression and tension wood were chosen as they provide interesting material with expected differences in lignin and cellulose amount and composition also within the secondary cell wall.

Experimental:

Raman spectra and Raman images were taken on cross sections (*Picea abies* 5µm thick, *Populus nigra* x *Populus deltoides* 10µm thick) in water using a Confocal Raman Microscope (CRM200, Witec) equipped with a piezo scanner (P-500, Physik Instrumente) and high NA microscope objectives (x 60, NA = 0.80 or 100 oil NA = 1.25, Nikon). A linear polarized laser (diode pumped Green laser, λ = 532 nm, CrystaLaser) was focused with a diffraction limited spot size (diameter approximately, λ/2) and the Raman light was detected by an air-cooled CCD (PI-MAX, Princeton Instruments) behind a grating (600 g mm⁻¹) spectrograph (Acton) with a resolution of 6 cm⁻¹.

TENSION WOOD

Sum [200 -> 3650 rel. 1/cm]



- clear spectral differences between cell corner (CC), middle lamella ML, S2 and the G-layer, basis analysis allows clear differentiation
- decreasing lignin bands (e.g. 1607cm⁻¹) (CC > ML > S2) and changes in band height ratios show differences in the lignin content and composition; G-layer lignin-free
- changing peak height ratios of cellulose peaks between G-layer and S2 (C-O-C 1099cm⁻¹ / CH2 2905cm⁻¹)

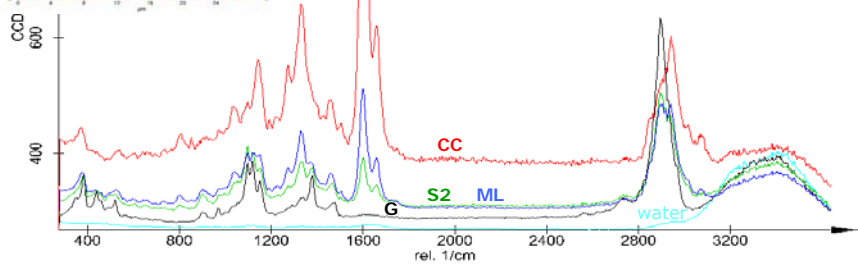
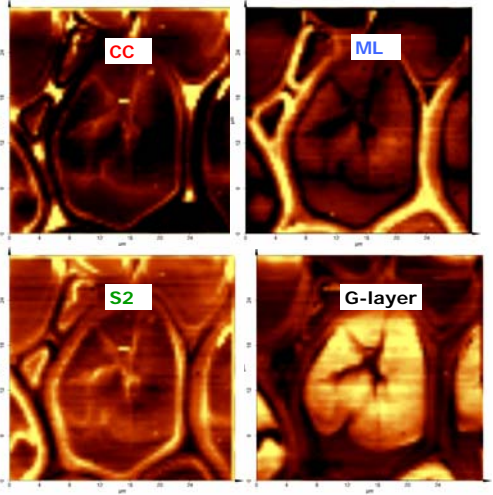


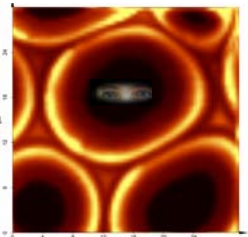
Fig.1: Average spectra of the differentiated cell wall layers

BASIS ANALYSIS : Spectra are fitted to the reference spectra shown in Fig. 1

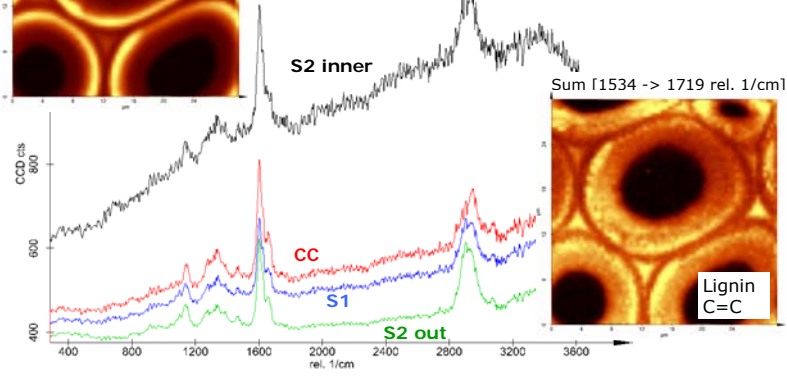


COMPRESSION AND OPPOSITE WOOD

Sum [200 -> 3650 rel. 1/cm]

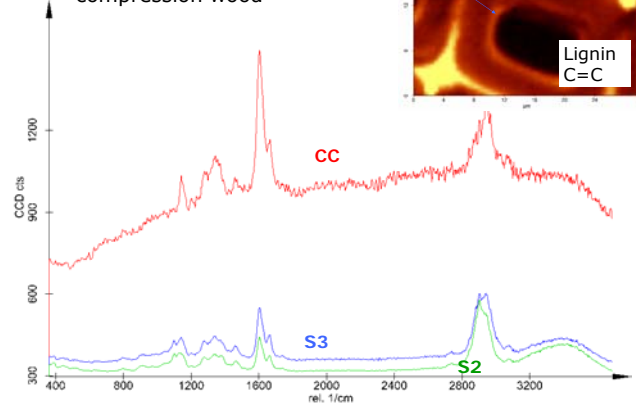
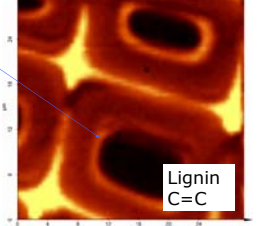


- high fluorescence in compression wood due to higher and different lignin composition; mainly lignin peaks
- different lignin content and composition in CC, S1 and within the S2 (highly fluorescing inner S2 and less lignified outer S2)



- more lignified inner S3 in the opposite wood
- composition of CC similar to the inner S2 layer in compression wood

Sum [1534 -> 1719 rel. 1/cm]



OUTLOOK: Raman microscopy enables a clear differentiation of the cell wall layers and gives also information on their chemical composition

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