Structural Changes in Tension Wood Help Explain Higher Digestibility

Objective:

- Determine why tension wood, a reaction wood to bending/leaning stress, undergoes higher enzymatic conversion to fermentable sugars.

Approach:

- Employed structural techniques, small-angle neutron scattering (SANS) and wide-angle X-ray diffraction (WAXD) to elucidate hierarchical structure and morphology of tension wood.

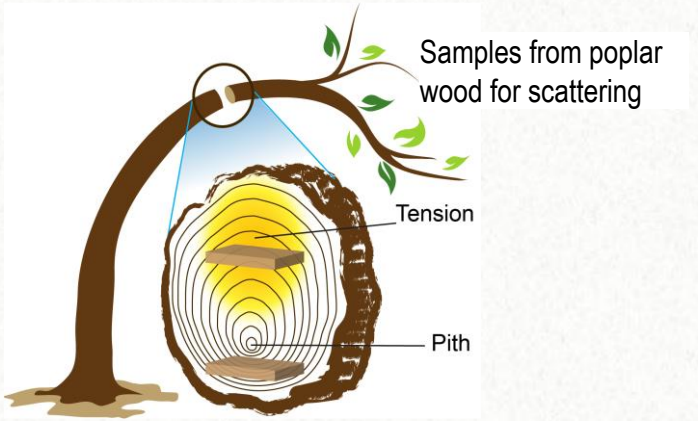
Results:

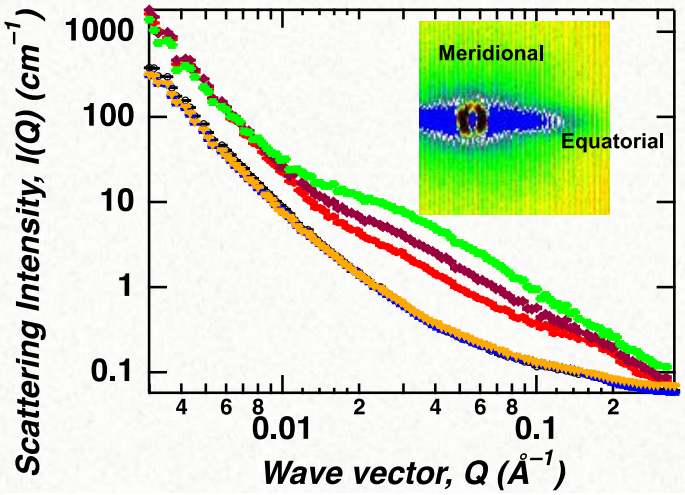
- Size distribution analysis of SANS data showed three main particle sizes- 22, 45, and 61 Å; WAXD resulted in cellulose crystallites of ~22 and ~42 Å.
- The smallest size, 22 Å observed in all samples was interpreted as the cellulose elementary microfibril diameter.
- 45 Å, most pronounced in the tension side sample and consistent with tension side WAXD results, indicates coalesced microfibrils.
- The largest size 61 Å observed by SANS alone, interpreted as mesopores.

Significance

- Structure and morphology of tension wood is different from control wood.
- Cellulose crystallinity increases, lignin content reduced and abundance of mesopores (average size ~ 61 Å).
- Despite higher content of crystalline cellulose in tension side, lower lignin and may be an abundance of mesopores, substantially improves enzyme accessibility leading to higher yields in cellulose digestion

This work was led by BER Biofuels SFA at ORNL (Dynamic Visualization of Lignocellulose Degradation …) in collaboration with BESC and CSMB





SANS profiles of poplar wood plotted as scattering intensity, I(Q) vs. wave vector, Q for meridional and equatorial sectors. Tension side (green), opposite side (red) and control (purple) curves show distinct equatorial sector scattering signals compared to the meridional sector scattering signal curves of the tension side (orange), opposite side (blue) and control (black) samples.

Sawada, Kalluri, O'Neill, Urban, Langan, Davison, and Pingali "Tension wood structure and morphology conducive for better enzymatic digestion," **accepted Biotech Biofuels** (2018)