Stress generation in the tension wood of poplar is based on the lateral swelling power of the G-layer

Abstract

The mechanism of active stress generation in tension wood is still not fully understood. To characterize the functional interdependency between the G-layer and the secondary cell wall, nanostructural characterization and mechanical tests were performed on native tension wood tissues of poplar (Populus nigra x Populus deltoids) and on tissues in which the G-layer was removed by an enzymatic treatment. In addition to the well- known axial orientation of the cellulose fibrils in the G-layer, it was shown that the microfibril angle of the S2- layer was very large (about 36). The removal of the G-layer resulted in an axial extension and a tangential contraction of the tissues. The tensile stress–strain curves of native tension wood slices showed a jagged appearance after yield that could not be seen in the enzyme-treated samples. The behaviour of the native tissue was modelled by assuming that cells deform elastically up to a critical strain at which the G-layer slips, causing a drop in stress. The results suggest that tensile stresses in poplar are generated in the living plant by a lateral swelling of the G-layer which forces the surrounding secondary cell wall to contract in the axial direction.

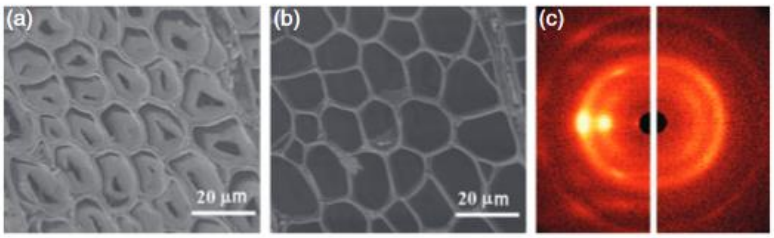

Figure 1. Effect of enzymatic treatment on the tension wood fibres.
Scanning electron microscopy image of (a) a cross-section of the native tension wood tissue with cell lumina almost completely filled with G-layers, (b) the same tissue after enzymatic treatment with complete degradation of the G-layers.
(c) Wide-angle X-ray scattering diffraction pattern of poplar tension wood with a G-layer (left) and after enzymatic removal of the G-layer (right).