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Micro-Characterization Techniques in Wood Mechanics

STIFFNESS OF THE ISOLATED ARABIDOPSIS CELL WALL DURING SOAKING

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The plant cell wall (CW) consists of the fibrillar (cellulose) and branched (lignin, pectin) macromolecules. They are able to store water thereby increasing their volume (hydration, absorption). This is vital for physiological processes in the apoplastic space, defense from microorganisms' attack and transport of water and nutrients. The water absorption by wood CW frequently assumes great importance. Understanding water absorption by wood during soaking is of practical importance, since it affects the mechanical properties of the product.

We chose the CW isolated from arabidopsis stems as a model system to study changes in surface stiffness distribution during 3-hour soaking. The CW was extracted using a series of solvents and the cellulase/pectinase treatment. Imaging and measurements of CW elastic (Young's) modulus were performed by using Bioscope I AFM operating in the force volume imaging mode. The CW was fixed onto a glass surface during successive imaging in air and phosphate buffer pH 7. We scanned a surface of 5x5 µm with a 32x32 pixel resolution. The analysis of the curves by homemade software OpenFovea permitted calculation of the sample topography and its Young's modulus. On the topographic images of the CW, flat surface was observed with attached globular structures, proposed to consist of lignin. Swelling of the CW structure was obvious during soaking. A parallel decrease in surface stiffness occurred. The elastic modulus changed from 10^9 Pa in the dry CW to $400 \cdot 10^6$ Pa after 3 h of soaking. This is evident on the histograms of surface distribution of stiffness and on CW stiffness maps.