NANOINDENTATION OF WOOD CELL WALLS: EFFECTS OF DIFFERENT SAMPLE PREPARATION METHODS

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Motivation

Nanoindentation [1] has established itself as the method of choice when investigating mechanical properties of wood cell walls [2,3]. In addition to the S2 layer, also the middle lamella can be investigated using the REF NI-specimen. In addition to the S2 layer, also the middle lamella can be investigated using the REF NI-specimen.

Material and Experimental Methods

Material and Sampling

A piece of Norway spruce (Picea abies [L] Karst.) wood (a) was cut in five cubes (b). After four of these cubes faced further processing, specimens for nano-indentation were prepared (c) from all five cubes.

Sample Processing and Preparation

Four cubes were subjected to repeated wetting and drying cycles resulting in a series of 1 to 4 cycles (D1 to D4) next to the untreated reference (REF).

Nanoindentation Tests

The reference (REF) and Fmax indentation parameters for the CCML were identified using the REF NI-specimen.

Results & Discussion

Indenting the Cell Corner Middle Lamella (CCML)

H in CCML showed a slight overall decrease, which did not become significant (p>0.01). M remained at the same level until indentation depths h of ~250-300 nm and then showed an increase with higher indentation depths. Consequently, suitable indentation depths would lie in the range of 150-180 nm.

Repeated Drying and Wetting

After repeated drying, losses of dry mass occurred, while the EMC did not change. Thus, it can be assumed that no carbohydrates were lost during repeated wetting and drying. No significant changes of M in the S2 layer and in the CCML were observed (p>0.01), while H slightly, but also not significantly (p>0.01), increased in both the S2 layer and the CCML. An extraction of soluble agents during the repeated wetting might explain this increase, as these agents act as plasticizers in the cell walls.

Different Embedding Procedures

Embedding in a different resin (E1) did not result in significantly different M and H (p>0.01). Neither the different mechanical properties nor the different curing temperatures had an effect on M and H. The tests on the non-embedded cell walls (E2) also did not show significantly different (p>0.01) M and H. However, the variability (SD) increased, compared to the reference values, by a factor of 3 and 2 for M and H, respectively. This higher experimental scatter might result from the sample preparation process, inducing cracks and delaminations in the cell walls.

References:


30th DANUBIA-ADRIA SYMPOSIUM on Advances in Experimental Mechanics, September 25-28, Primošten, Croatia