
Water uptake in wood explained by in situ X-ray tomography observation and digital volume correlation

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Abstract

Wood imbibition by liquids such as aqueous solutions is a relevant processing route to process wood-based products as autoclave or densified woods, *i.e.*, lightweight biosourced materials with optimized functional and structural properties. However, wood imbibition involves complex and coupled mechanisms, *e.g.*, capillary effects, diffusion in wood cell walls, and hygro-expansion of these cell walls, which are not fully understood. Within this context, we performed water imbibition of beech samples at macroscale and at mesoscale with 3D *in situ* observations of samples using X-ray tomography. The acquired 3D images were compared using Digital Volume Correlation (DVC). We obtained simultaneously quantitative information of (i) the impregnation of "free" water in the vessels from the correlation errors, (ii) anisotropic hygro-expansion of wood, from the 3D local strain fields, which gives (iii) the diffusion of bound water inside the wood cell walls. Impregnation induced by capillary effects is faster than diffusion, with an equilibrium state obtained after a few hours for capillary uptake and few weeks for diffusion for a sample size of 5 cm. The kinetics of both phenomena are compared with analytical predictors to extract relevant impregnation and diffusion constitutive parameters.

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