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Water vapour sorption and moisture transport in and across fibre direction of wood

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Samples with different thickness in radial direction

An evaluation of the absorption and desorption kinetics for samples with a thickness between 0.5 mm and 2 mm in radial direction (i.e. across fibre direction) during an exemplary step change in RH is given in Fig. S1a,b. Differences in the kinetics among the various samples exist and the mass change is noticeable slower than for the longitudinal samples (see Fig. 3 in the main manuscript). The impact of sample thickness is significant for the uptake and release of water in the initial phase (Fig. S1c,d) as well as in the later phase (Fig. S1e,f).

Samples with different anatomical orientation

Low range of RH:

Similar to the comparison of the sorption kinetics between longitudinal and tangential samples (see Fig. 5 in the main manuscript), radial samples show a considerable slower uptake (Fig. S2a) and release of water (Fig. S2b) than longitudinal samples at low RH. Thicker samples have a slower normalised mass change than the thinner samples, which is indicated by the arrows for each anatomical orientation. An illustration of the measured mass change in the $\sqrt{t/d^2}$ representation (Fig. S2c,d) shows a delayed uptake and release of water for the thinner samples (compared to a simple diffusion process with an instantaneous change of boundary conditions).

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High range of RH:

In the high range of RH, the sorption kinetics of samples in longitudinal and radial direction show a remarkable similarity during absorption (Fig. S3a) and particularly during desorption (Fig. S3b). Similar to the comparison between longitudinal and tangential samples (see Fig. 6 in the main manuscript), an identical uptake and release of water between the longitudinal and radial samples is seen for the thinnest samples. For thicker samples, differences between the kinetics of the longitudinal and radial samples were detected. At high RH, the significant differences in the sorption kinetics among samples with a different thickness shows that sample thickness still has a considerable impact. A representation of the sorption kinetics over $\sqrt{t/d^2}$ (Fig. S3c,d) indicates that both the shape of the sorption kinetics and the differences among samples with a different thickness deviate considerably from a diffusion behaviour (cf. Fig. 6b in the main manuscript).

Transition low to high range of RH:

The ratio between the mass change of the radial and longitudinal samples ($\Delta M_R/\Delta M_L$) for each sample thickness is shown in Figure S4. Evaluation time for the ratio was chosen to $t_{ev} = 10\,\text{min}$ to capture the initial phase of the sorption kinetics. For each sample thickness the ratio $\Delta M_R/\Delta M_L$ increases continuously with the moisture content of wood. Since for each thickness $\Delta M_R/\Delta M_L$ is similar between absorption and desorption, the involved processes have to be independent on the uptake and release of water. Comparing the three mass change ratios among each other, an increase of the ratio with decreasing sample thickness can be observed.

Change or RH inside the measuring chamber

For a step change in RH, a certain amount of time is needed until the desired humidity is reached inside the measuring chamber. Since RH of the dynamic vapour sorption device used is changed by the inflow of dry or water vapour-saturated air (see Section 2.1 in the main manuscript), the time requested for a step change in RH varies with humidity in the measuring chamber. During absorption, humidity is thus changed fast in the low and mid range of RH, while in the high range a change of RH takes much longer (Fig. S5a). Similarly, during desorption humidity is changed fast in the high and mid range of RH, while in the low range a change of RH takes much longer (Fig. S5b). These non-instantaneous and different changes of RH must be taken into account for the interpretation of the measured sorption kinetics as well as for a corresponding simulation of the processes involved (see Fig. 6 in the main manuscript).

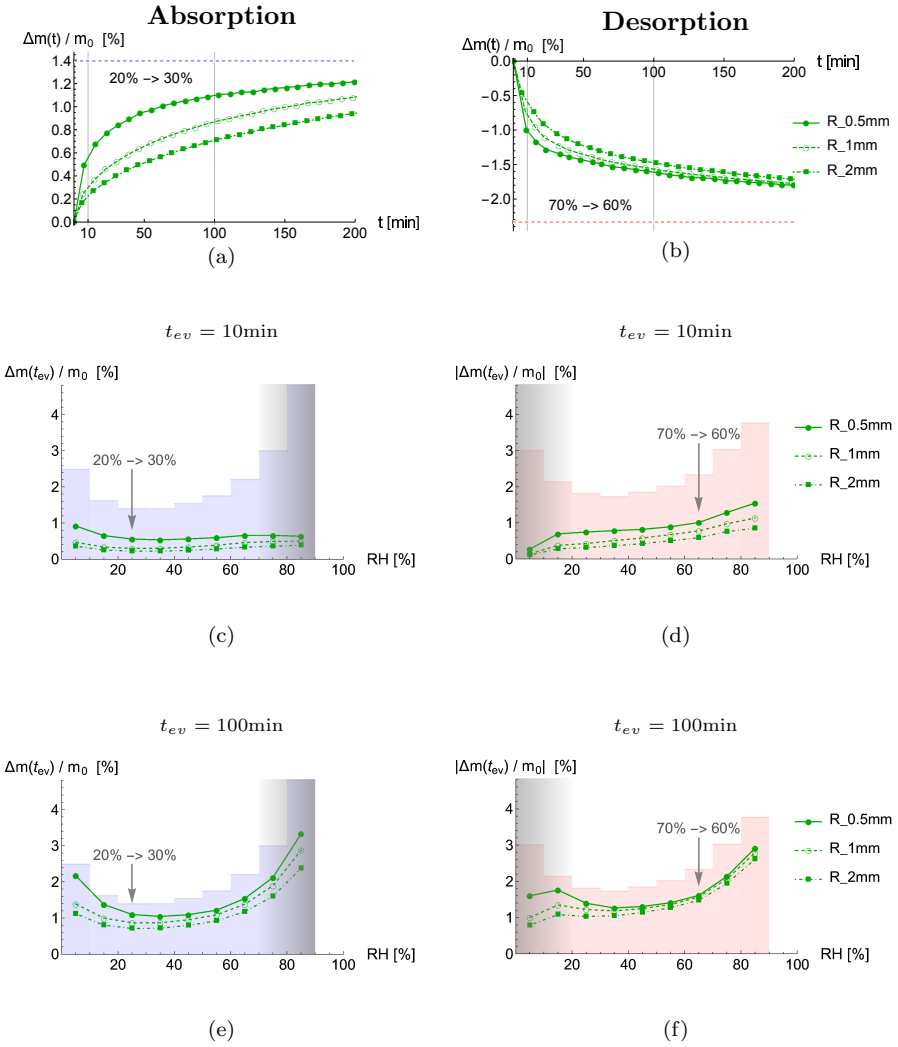

Fig. S1: Comparison of the absorption (left) and desorption behaviour (right) between radial samples with different thickness. First row shows the sorption kinetics for a selected step change in absorption (**a**) and desorption (**b**). Middle row shows the uptake (**c**) and release of water (**d**) after 10 min for each step change in RH and the last row shows the uptake (**e**) and release of water (**f**) after 100 min. Note that the mass change in Figure (**d**,**f**) show absolute values. Markers were placed in the middle of each step change in RH and bars in the background show the total mass change when EC was fulfilled. The grey area indicates the range with a slow change of RH inside the measuring chamber. Error bars were omitted for a better comparability and the interpolated lines between the measured data are for illustration purposes only

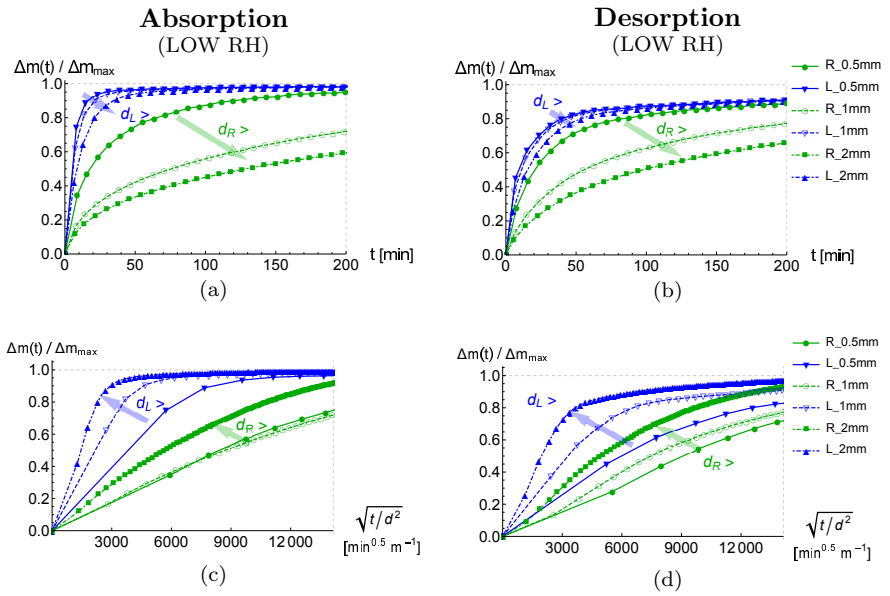

Fig. S2: Comparison of the sorption kinetics between samples with a different thickness in the longitudinal (blue) and radial (green) direction in the low range of RH. Absorption kinetics (0% → 10% RH) are shown left (**a**,**c**) and desorption kinetics (20% → 10% RH) right (**b**,**d**). Error bars were omitted for a better comparability and the interpolated lines are for illustration purposes only

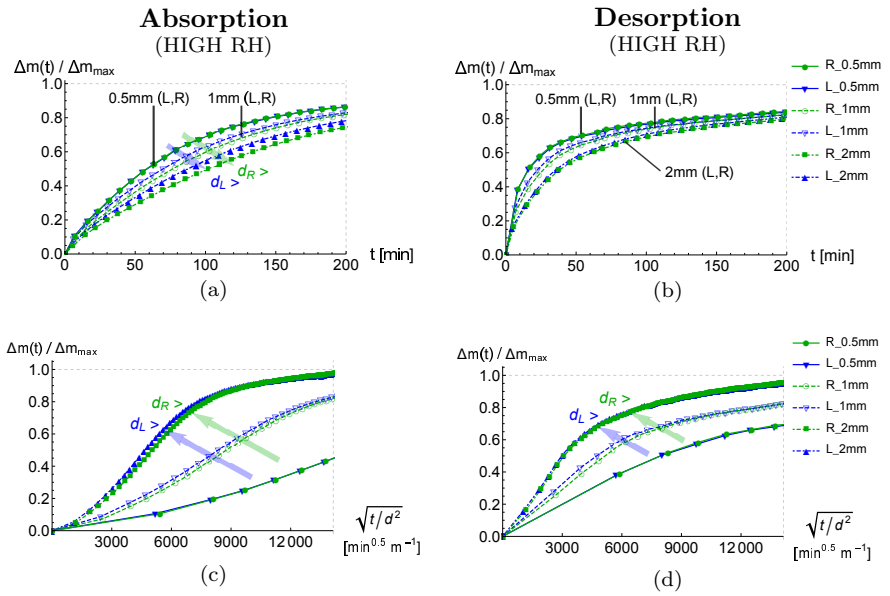

Fig. S3: Comparison of the sorption kinetics between samples with a different thickness in the longitudinal (blue) and radial (green) direction in the high range of RH. Absorption kinetics (80% → 90% RH) are shown left (**a**,**c**) and desorption kinetics (90% → 80% RH) right (**b**,**d**). Error bars were omitted for a better comparability and the interpolated lines are for illustration purposes only

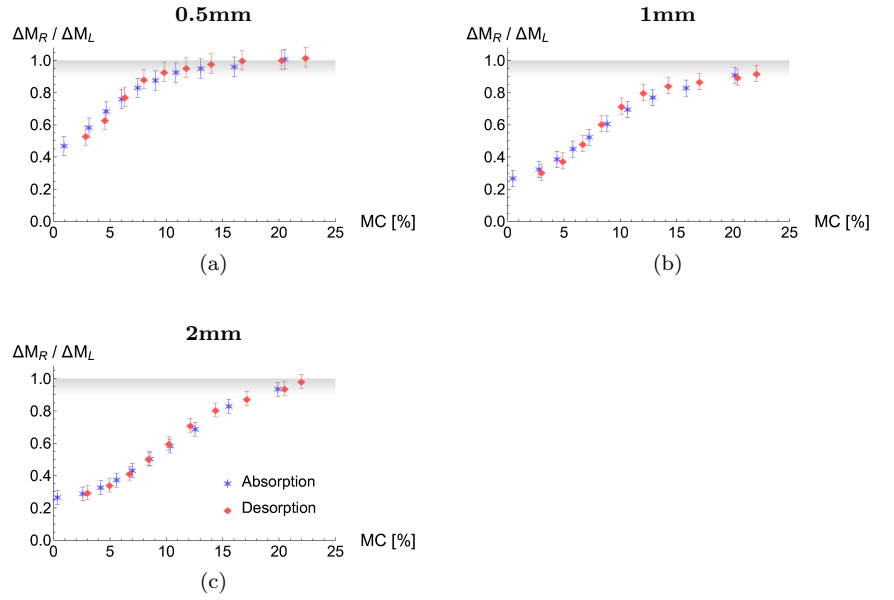

Fig. S4: Initial mass change ratio between radial and longitudinal samples during absorption (✶) and desorption (◆) for a sample thickness of 0.5 mm (**a**), 1 mm (**b**), and 2 mm (**c**). Grey area indicates the range with a similar sorption kinetic between the radial and longitudinal samples

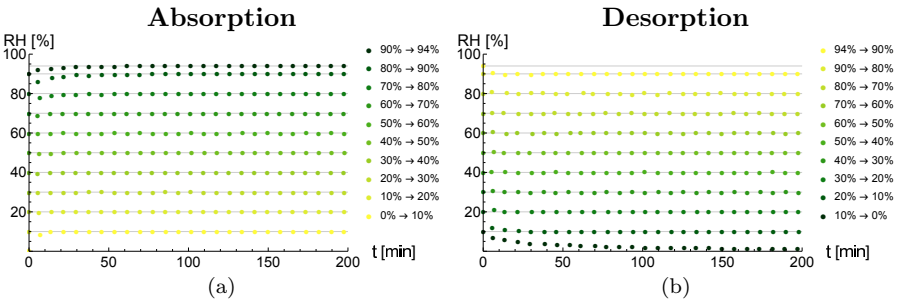

Fig. S5: Illustration of the measured RH inside the measuring chamber for each step change during absorption (**a**) and desorption (**b**). Step changes with a slow change of RH are shown with dark colors