SUPPLEMENTARY INFORMATION

# Anisotropic Wood-Water Interactions Determined by Gravimetric Vapor Sorption Experiments

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Figure SI-1. Beech disks with the three wood orthotropic directions perpendicular to the disk plane: a) disk1-L – longitudinal -, b) disk2-R – radial - and c) disk3-T - tangential.
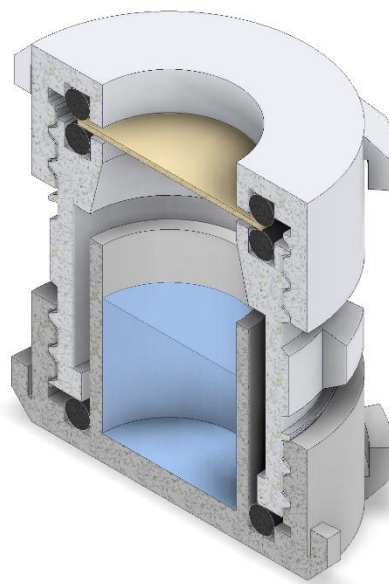


Figure SI-2. Cross-section along the cylindrical axis of the 3D-printed DVT cup. The upper component is used to attach the wood sample between two O-ring seals while the bottom component is used either as a water reservoir or as a drying agent container.
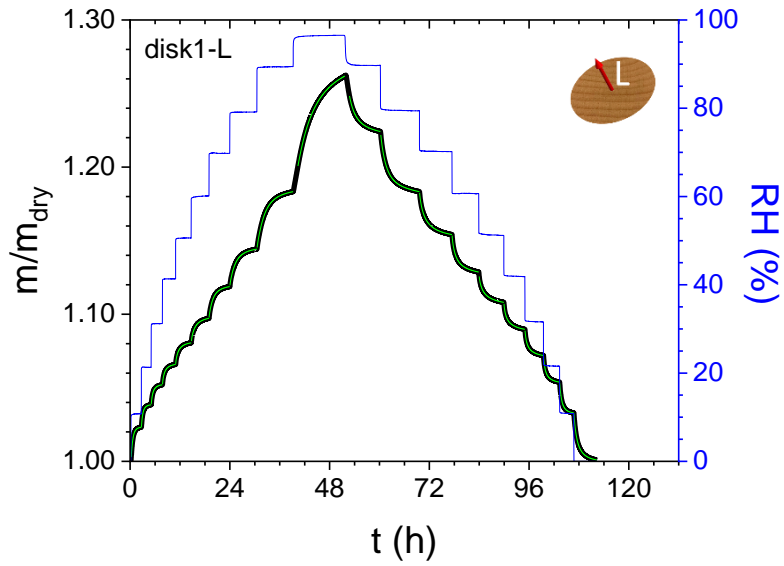
Figure SI-3. DVS adsorption/desorption experiment for the disk1-L. The green lines are the fitting curves following the double stretched exponential (DSE) model.

Table SI-1. Double stretched exponential fitting parameters ((m/m$_{dry}$)$_{eq}$, A$_1$, A$_2$, $\tau_1$, $\tau_2$, $\beta_1$, $\beta_2$) and the equivalent lifetime ($\tau$), stretched exponential factor ($\beta$) and kinetic constant (k), and the diffusion coefficient (D) for each adsorption/desorption step in the DVS experiment for the disk1-L.

| RH [%] | (m/m$_{dry}$)$_{eq}$ | A$_1$ | A$_2$ | $\tau_1$ [min] | $\tau_2$ [min] | $\beta_1$ | $\beta_2$ | $\tau$ [min] | $\beta$ | k [s$^{-1}$] | D [m$^2$/s] | R |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10.82 | 1.0234 | -0.01913 | -0.00139 | 23.96 | 106.9 | 1.052 | 1.210 | 26.42 | 0.893 | 6.31E-04 | 1.37E-10 | 0.9996 |
| 21.31 | 1.0388 | -0.01041 | -0.00492 | 16.88 | 54.52 | 1.037 | 1.069 | 23.82 | 0.771 | 7.00E-04 | 1.52E-10 | 0.9996 |
| 31.21 | 1.0525 | -0.00771 | -0.00584 | 16.86 | 62.65 | 0.954 | 0.982 | 29.89 | 0.729 | 5.58E-04 | 1.21E-10 | 0.9999 |
| 41.34 | 1.0665 | -0.00729 | -0.00663 | 19.72 | 76.72 | 0.896 | 0.937 | 38.69 | 0.715 | 4.31E-04 | 9.35E-11 | 0.9998 |
| 50.61 | 1.0813 | -0.00650 | -0.00852 | 22.50 | 83.26 | 0.851 | 0.897 | 49.32 | 0.731 | 3.38E-04 | 7.34E-11 | 0.9999 |
| 60.11 | 1.0988 | -0.00809 | -0.00889 | 44.30 | 115.3 | 0.877 | 0.745 | 68.57 | 0.650 | 2.43E-04 | 5.28E-11 | 0.9996 |
| 69.81 | 1.1199 | -0.00389 | -0.01824 | 50.41 | 76.22 | 1.363 | 0.757 | 66.99 | 0.734 | 2.49E-04 | 5.41E-11 | 0.9998 |
| 79.16 | 1.1456 | -0.00366 | -0.02231 | 69.84 | 103.0 | 1.490 | 0.786 | 93.09 | 0.765 | 1.79E-04 | 3.90E-11 | 0.9999 |
| 89.45 | 1.1860 | -0.01406 | -0.02662 | 96.41 | 180.3 | 1.240 | 0.777 | 131.9 | 0.714 | 1.26E-04 | 2.75E-11 | 0.9994 |
| 96.52 | 1.2735 | -0.03053 | -0.04221 | 155.3 | 516.8 | 1.021 | 1.031 | 323.3 | 0.830 | 5.15E-05 | 1.12E-11 | 0.9998 |
| 89.75 | 1.2211 | 0.01459 | 0.01263 | 71.18 | 317.5 | 0.992 | 1.055 | 150.6 | 0.747 | 1.11E-04 | 2.41E-11 | 0.9992 |
| 79.42 | 1.1786 | 0.02516 | 0.01801 | 70.01 | 390.4 | 0.961 | 0.836 | 136.2 | 0.576 | 1.22E-04 | 2.66E-11 | 0.9995 |
| 70.19 | 1.1514 | 0.01418 | 0.01685 | 49.92 | 223.1 | 0.869 | 0.810 | 113.2 | 0.636 | 1.47E-04 | 3.20E-11 | 0.9998 |
| 60.66 | 1.1254 | 0.01615 | 0.01193 | 42.55 | 282.8 | 0.838 | 0.851 | 98.23 | 0.578 | 1.70E-04 | 3.69E-11 | 0.9991 |
| 51.21 | 1.1055 | 0.00980 | 0.01041 | 40.53 | 239.2 | 0.831 | 0.845 | 108.0 | 0.625 | 1.54E-04 | 3.35E-11 | 0.9992 |
| 41.85 | 1.0883 | 0.00767 | 0.01106 | 21.77 | 130.6 | 0.865 | 0.857 | 68.76 | 0.661 | 2.42E-04 | 5.26E-11 | 0.9990 |
| 31.61 | 1.0709 | 0.00824 | 0.00969 | 20.38 | 108.0 | 0.888 | 0.884 | 53.36 | 0.665 | 3.12E-04 | 6.78E-11 | 0.9992 |
| 21.57 | 1.0530 | 0.01026 | 0.00820 | 20.95 | 95.47 | 0.912 | 0.927 | 41.83 | 0.670 | 3.98E-04 | 8.64E-11 | 0.9997 |
| 10.83 | 1.0322 | 0.01402 | 0.00673 | 25.56 | 84.39 | 0.941 | 0.918 | 35.60 | 0.694 | 4.68E-04 | 1.01E-10 | 0.9992 |
| 0.00 | 1.0000 | 0.01726 | 0.01537 | 32.99 | 119.2 | 0.983 | 1.001 | 61.36 | 0.756 | 2.72E-04 | 5.88E-11 | 0.9998 |

Figure SI-4. DVS adsorption/desorption experiment for the disk2-R. The green lines are the fitting curves following the double stretched exponential (DSE) model.

Table SI-2. Double stretched exponential fitting parameters (($m/m_{dry})_{eq}$, $A_1$, $A_2$, $\tau_1$, $\tau_2$, $\beta_1$, $\beta_2$) and the equivalent lifetime ($\tau$), stretched exponential factor ($\beta$) and kinetic constant (k), and the diffusion coefficient (D) for each adsorption/desorption step in the DVS experiment for the disk2-R.

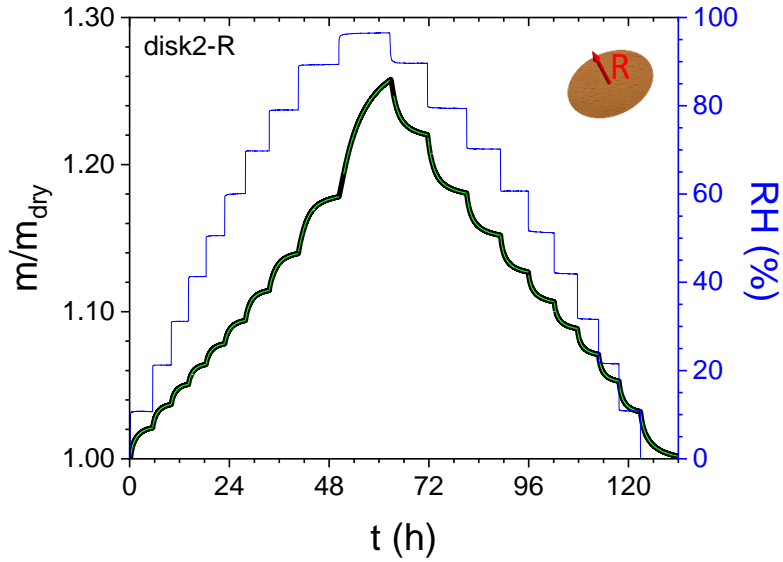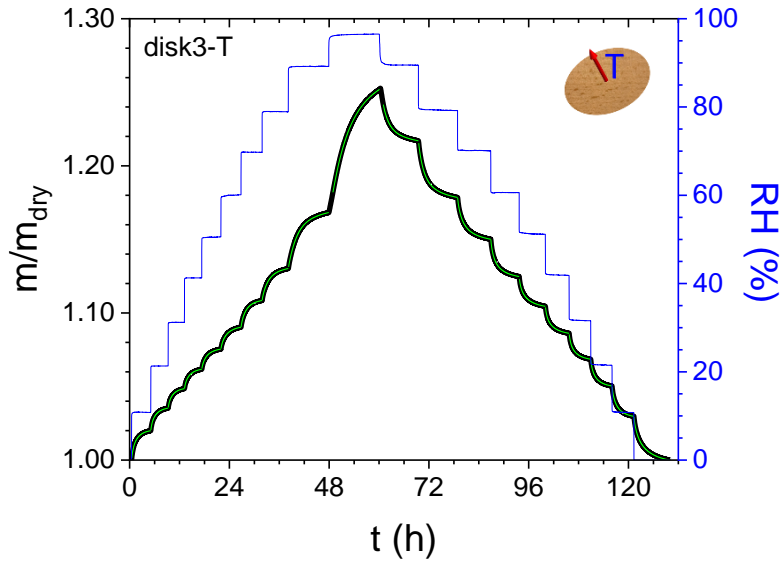| RH [%] | $(m/m_{dry})_{eq}$ | $A_1$ | $A_2$ | $\tau_1$ [min] | $\tau_2$ [min] | $\beta_1$ | $\beta_2$ | $\tau$ [min] | $\beta$ | k [$s^{-1}$] | D [$m^2/s$] | R |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10.70 | 1.0221 | -0.00407 | -0.01669 | 21.30 | 106.1 | 0.975 | 0.918 | 83.90 | 0.823 | 1.99E-04 | 3.92E-11 | 0.9997 |
| 21.25 | 1.0378 | -0.00145 | -0.01504 | 14.72 | 80.55 | 1.051 | 0.872 | 72.75 | 0.832 | 2.29E-04 | 4.55E-11 | 0.9999 |
| 31.17 | 1.0514 | -0.00141 | -0.01273 | 15.62 | 78.65 | 0.950 | 0.882 | 70.26 | 0.838 | 2.37E-04 | 4.73E-11 | 0.9999 |
| 41.29 | 1.0649 | -0.00063 | -0.01345 | 13.79 | 75.08 | 1.147 | 0.849 | 71.29 | 0.829 | 2.34E-04 | 4.70E-11 | 1.0000 |
| 50.56 | 1.0790 | -0.00128 | -0.01317 | 16.30 | 83.94 | 0.885 | 0.885 | 76.13 | 0.846 | 2.19E-04 | 4.43E-11 | 1.0000 |
| 60.11 | 1.0955 | -0.00552 | -0.01158 | 57.24 | 115.5 | 0.907 | 0.792 | 89.34 | 0.739 | 1.87E-04 | 3.80E-11 | 0.9999 |
| 69.74 | 1.1159 | -0.00424 | -0.01736 | 63.85 | 106.6 | 1.183 | 0.775 | 91.76 | 0.745 | 1.82E-04 | 3.73E-11 | 0.9998 |
| 79.04 | 1.1409 | -0.00119 | -0.02486 | 93.01 | 120.2 | 1.130 | 0.844 | 116.6 | 0.836 | 1.43E-04 | 2.98E-11 | 1.0000 |
| 89.36 | 1.1832 | -0.01962 | -0.02273 | 113.8 | 326.0 | 1.174 | 0.715 | 171.5 | 0.596 | 9.72E-05 | 2.07E-11 | 0.9994 |
| 96.50 | 1.2705 | -0.0356 | -0.04154 | 166.4 | 584.9 | 1.007 | 1.308 | 370.2 | 0.997 | 4.50E-05 | 9.80E-12 | 0.9992 |
| 89.66 | 1.2178 | 0.01415 | 0.01496 | 72.38 | 273.8 | 0.998 | 1.008 | 148.1 | 0.768 | 1.13E-04 | 2.40E-11 | 0.9997 |
| 79.40 | 1.1775 | 0.01877 | 0.02226 | 72.73 | 241.9 | 1.003 | 0.800 | 130.9 | 0.651 | 1.27E-04 | 2.65E-11 | 0.9999 |
| 70.17 | 1.1493 | 0.01333 | 0.01736 | 56.51 | 221.7 | 0.887 | 0.803 | 121.3 | 0.650 | 1.37E-04 | 2.83E-11 | 0.9999 |
| 60.68 | 1.1251 | 0.01008 | 0.01646 | 36.35 | 158.7 | 0.881 | 0.844 | 94.27 | 0.689 | 1.77E-04 | 3.60E-11 | 0.9997 |
| 51.21 | 1.1047 | 0.00708 | 0.01318 | 37.35 | 177.9 | 0.869 | 0.827 | 108.7 | 0.682 | 1.53E-04 | 3.10E-11 | 0.9996 |
| 41.88 | 1.0871 | 0.00724 | 0.01183 | 27.76 | 143.3 | 0.871 | 0.884 | 83.76 | 0.707 | 1.99E-04 | 4.00E-11 | 0.9994 |
| 31.59 | 1.0698 | 0.00690 | 0.01127 | 26.53 | 123.6 | 0.887 | 0.896 | 73.98 | 0.723 | 2.25E-04 | 4.50E-11 | 0.9995 |
| 21.52 | 1.0517 | 0.00699 | 0.01167 | 27.86 | 113.8 | 0.891 | 0.906 | 71.01 | 0.744 | 2.35E-04 | 4.66E-11 | 0.9997 |
| 10.82 | 1.0310 | 0.00600 | 0.01530 | 27.43 | 102.9 | 0.905 | 0.896 | 74.28 | 0.780 | 2.24E-04 | 4.43E-11 | 0.9998 |
| 0.00 | 0.9993 | 0.00871 | 0.02382 | 43.26 | 208.7 | 0.923 | 0.852 | 146.1 | 0.733 | 1.14E-04 | 2.24E-11 | 0.9996 |

Figure SI-5. DVS adsorption/desorption experiment for the disk3-T. The green lines are the fitting curves following the double stretched exponential (DSE) model.

Table SI-3. Double stretched exponential fitting parameters ((m/m$_{dry}$)$_{eq}$, A$_1$, A$_2$, $\tau_1$, $\tau_2$, $\beta_1$, $\beta_2$) and the equivalent lifetime ($\tau$), stretched exponential factor ($\beta$) and kinetic constant (k), and the diffusion coefficient (D) for each adsorption/desorption step in the DVS experiment for the disk3-T.

| RH [%] | (m/m$_{dry}$)$_{eq}$ | A$_1$ | A$_2$ | $\tau_1$ [min] | $\tau_2$ [min] | $\beta_1$ | $\beta_2$ | $\tau$ [min] | $\beta$ | k [s$^{-1}$] | D [m$^2$/s] | R |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10.80 | 1.0208 | -0.00527 | -0.01418 | 22.94 | 88.91 | 0.944 | 0.939 | 65.27 | 0.816 | 2.55E-04 | 5.49E-11 | 0.9998 |
| 21.31 | 1.0361 | -0.00233 | -0.01332 | 15.24 | 76.61 | 0.995 | 0.884 | 64.14 | 0.815 | 2.60E-04 | 5.64E-11 | 0.9999 |
| 31.19 | 1.0494 | -0.00158 | -0.01208 | 14.27 | 74.78 | 0.976 | 0.872 | 65.28 | 0.820 | 2.55E-04 | 5.59E-11 | 0.9999 |
| 41.29 | 1.0625 | -0.00161 | -0.01224 | 15.48 | 78.86 | 0.948 | 0.867 | 68.85 | 0.816 | 2.42E-04 | 5.35E-11 | 0.9999 |
| 50.56 | 1.0766 | -0.00545 | -0.00885 | 44.91 | 112.0 | 0.822 | 0.847 | 79.89 | 0.759 | 2.09E-04 | 4.66E-11 | 1.0000 |
| 60.13 | 1.0918 | -0.01161 | -0.00436 | 71.83 | 179.4 | 0.823 | 0.793 | 87.68 | 0.690 | 1.90E-04 | 4.29E-11 | 0.9990 |
| 69.72 | 1.1102 | -0.01578 | -0.00394 | 68.36 | 268.8 | 0.858 | 0.878 | 82.71 | 0.641 | 2.02E-04 | 4.62E-11 | 0.9977 |
| 78.90 | 1.1319 | -0.00348 | -0.01970 | 72.25 | 123.1 | 1.194 | 0.794 | 109.6 | 0.768 | 1.52E-04 | 3.55E-11 | 0.9999 |
| 89.20 | 1.1748 | -0.01905 | -0.02448 | 114.0 | 391.8 | 1.134 | 0.723 | 200.9 | 0.587 | 8.30E-05 | 2.00E-11 | 0.9999 |
| 96.50 | 1.2636 | -0.05602 | -0.02556 | 203.0 | 694.2 | 1.037 | 1.537 | 329.7 | 0.971 | 5.06E-05 | 1.25E-11 | 0.9990 |
| 89.48 | 1.2132 | 0.01649 | 0.01195 | 78.48 | 445.8 | 0.982 | 1.034 | 172.1 | 0.675 | 9.68E-05 | 2.33E-11 | 0.9983 |
| 79.21 | 1.1743 | 0.02184 | 0.01931 | 70.81 | 333.1 | 0.958 | 0.813 | 139.4 | 0.601 | 1.20E-04 | 2.80E-11 | 0.9997 |
| 70.09 | 1.1440 | 0.02165 | 0.01264 | 68.72 | 654.3 | 0.828 | 0.895 | 167.3 | 0.535 | 9.96E-05 | 2.28E-11 | 0.9975 |
| 60.63 | 1.1230 | 0.01206 | 0.01486 | 37.15 | 175.8 | 0.864 | 0.879 | 92.56 | 0.681 | 1.80E-04 | 4.07E-11 | 0.9996 |
| 51.18 | 1.1028 | 0.00685 | 0.01334 | 31.78 | 162.7 | 0.846 | 0.870 | 102.4 | 0.718 | 1.63E-04 | 3.64E-11 | 0.9995 |
| 41.85 | 1.0847 | 0.00676 | 0.01231 | 26.58 | 142.1 | 0.870 | 0.870 | 85.85 | 0.705 | 1.94E-04 | 4.29E-11 | 0.9994 |
| 31.57 | 1.0672 | 0.00668 | 0.01150 | 26.81 | 128.7 | 0.872 | 0.889 | 78.22 | 0.721 | 2.13E-04 | 4.67E-11 | 0.9995 |
| 21.48 | 1.0493 | 0.00663 | 0.01214 | 27.14 | 114.2 | 0.872 | 0.889 | 73.08 | 0.739 | 2.28E-04 | 4.95E-11 | 0.9997 |
| 10.77 | 1.0287 | 0.00606 | 0.01500 | 25.85 | 107.5 | 0.887 | 0.901 | 76.15 | 0.776 | 2.19E-04 | 4.70E-11 | 0.9998 |
| 0.00 | 0.9977 | 0.00994 | 0.02156 | 41.74 | 207.7 | 0.888 | 0.890 | 136.7 | 0.743 | 1.22E-04 | 2.59E-11 | 0.9995 |
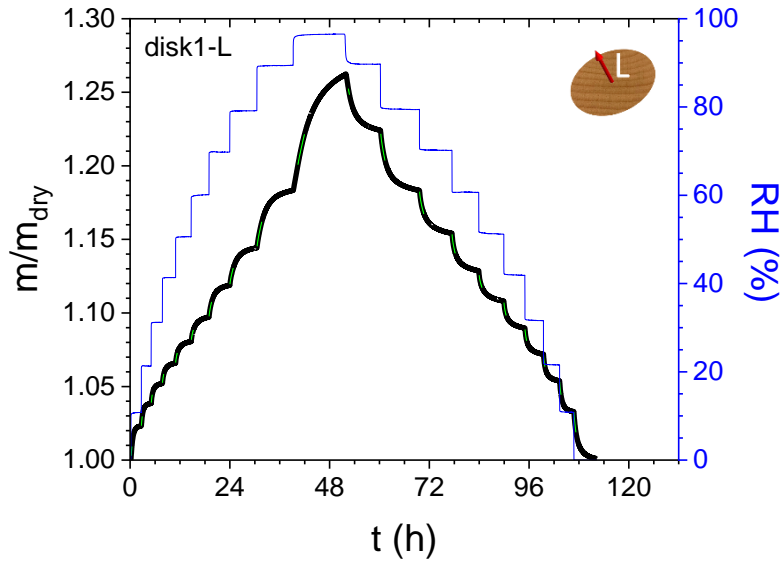
Figure SI-6. DVS adsorption/desorption experiment for the disk1-L. The green lines are the fitting curves following the Ritger-Peppas (RP) model.

Table SI-4. Ritger-Peppas fitting parameters (($m/m_{dry})_{eq}$, $\tau_{rp}$, $n_{rp}$), the corresponding kinetic constant ($k_{rp}$) and diffusion parameter ($D_{rp}$), the equivalent kinetic constant ($k'$), and diffusion coefficient ($D'$) for each adsorption/desorption step in the DVS experiment for the disk1-L.

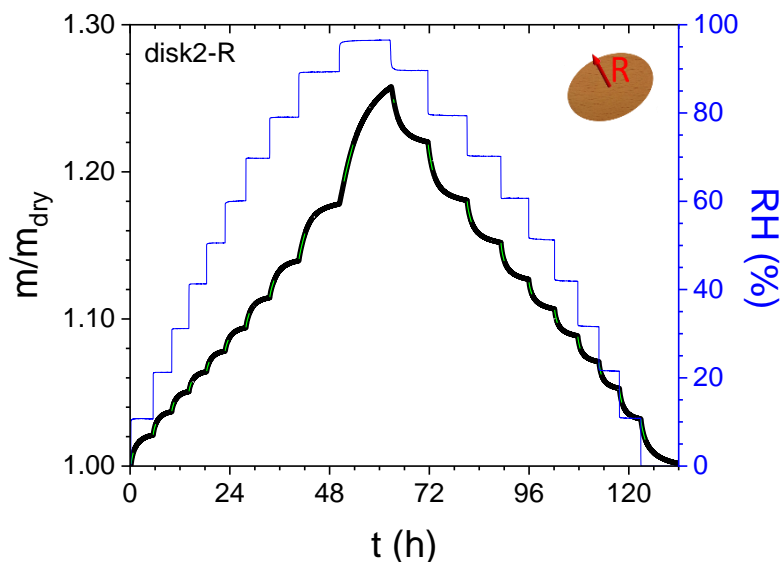| RH [%] | $(m/m_{dry})_{eq}$ | $\tau_{rp}$ [min] | $k_{rp}$ [s$^{-1}$] | $n$ | $D_{rp}$ [m$^2$/s] | $k'$ [s$^{-1}$] | $\beta'$ | $D'$ [m$^2$/s] |
|---|---|---|---|---|---|---|---|---|
| 10.82 | 1.0234 | 35.36 | 4.71E-04 | 0.930 | 1.02E-10 | 6.62E-04 | 1.068 | 1.43E-10 |
| 21.31 | 1.0388 | 32.90 | 5.07E-04 | 0.886 | 1.10E-10 | 7.23E-04 | 1.018 | 1.57E-10 |
| 31.21 | 1.0525 | 40.02 | 4.16E-04 | 0.813 | 9.03E-11 | 6.15E-04 | 0.937 | 1.33E-10 |
| 41.34 | 1.0665 | 53.79 | 3.10E-04 | 0.753 | 6.73E-11 | 4.73E-04 | 0.870 | 1.03E-10 |
| 50.61 | 1.0813 | 72.10 | 2.31E-04 | 0.711 | 5.02E-11 | 3.63E-04 | 0.823 | 7.88E-11 |
| 60.11 | 1.0988 | 105.74 | 1.58E-04 | 0.703 | 3.43E-11 | 2.49E-04 | 0.814 | 5.40E-11 |
| 69.81 | 1.1199 | 110.97 | 1.50E-04 | 0.718 | 3.27E-11 | 2.35E-04 | 0.830 | 5.10E-11 |
| 79.16 | 1.1456 | 151.22 | 1.10E-04 | 0.736 | 2.40E-11 | 1.70E-04 | 0.850 | 3.70E-11 |
| 89.45 | 1.1860 | 203.46 | 8.19E-05 | 0.803 | 1.78E-11 | 1.22E-04 | 0.926 | 2.65E-11 |
| 96.52 | 1.2735 | 377.2 | 4.42E-05 | 0.903 | 9.63E-12 | 6.27E-05 | 1.037 | 1.37E-11 |
| 89.75 | 1.2211 | 133.4 | 1.25E-04 | 0.951 | 2.72E-11 | 1.74E-04 | 1.091 | 3.79E-11 |
| 79.42 | 1.1786 | 183.42 | 9.09E-05 | 0.766 | 1.98E-11 | 1.38E-04 | 0.884 | 3.00E-11 |
| 70.19 | 1.1514 | 179.15 | 9.30E-05 | 0.660 | 2.02E-11 | 1.52E-04 | 0.766 | 3.30E-11 |
| 60.66 | 1.1254 | 143.24 | 1.16E-04 | 0.658 | 2.53E-11 | 1.90E-04 | 0.763 | 4.13E-11 |
| 51.21 | 1.1055 | 147.05 | 1.13E-04 | 0.672 | 2.46E-11 | 1.83E-04 | 0.779 | 3.98E-11 |
| 41.85 | 1.0883 | 98.56 | 1.69E-04 | 0.657 | 3.67E-11 | 2.76E-04 | 0.763 | 6.00E-11 |
| 31.61 | 1.0709 | 71.20 | 2.34E-04 | 0.714 | 5.08E-11 | 3.67E-04 | 0.826 | 7.95E-11 |
| 21.57 | 1.0530 | 57.43 | 2.90E-04 | 0.753 | 6.29E-11 | 4.43E-04 | 0.870 | 9.61E-11 |
| 10.83 | 1.0322 | 51.87 | 3.21E-04 | 0.800 | 6.96E-11 | 4.78E-04 | 0.923 | 1.03E-10 |
| 0.00 | 1.0000 | 83.73 | 1.99E-04 | 0.815 | 4.31E-11 | 2.94E-04 | 0.939 | 6.36E-11 |

Figure SI-7. DVS adsorption/desorption experiment for the disk2-R. The green lines are the fitting curves following the Ritger-Peppas (RP) model.

Table SI-5. Ritger-Peppas fitting parameters ($(m/m_{dry})_{eq}$, $\tau_{rp}$, $n_{rp}$), the corresponding kinetic constant ($k_{rp}$) and diffusion parameter ($D_{rp}$), the equivalent kinetic constant ($k'$), and diffusion coefficient ($D'$) for each adsorption/desorption step in the DVS experiment for the disk2-R.

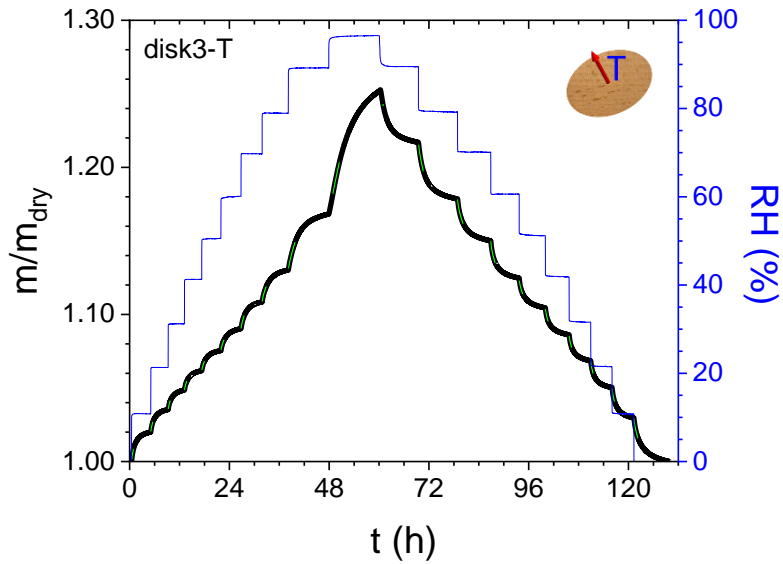| RH [%] | $(m/m_{dry})_{eq}$ | $\tau_{rp}$ [min] | $k_{rp}$ [s$^{-1}$] | $n$ | $D_{rp}$ [m$^2$/s] | $k'$ [s$^{-1}$] | $\beta'$ | $D'$ [m$^2$/s] |
|---|---|---|---|---|---|---|---|---|
| 10.70 | 1.0221 | 108.7 | 1.53E-04 | 0.767 | 3.03E-11 | 2.32E-04 | 0.886 | 4.58E-11 |
| 21.25 | 1.0378 | 110.3 | 1.51E-04 | 0.716 | 3.00E-11 | 2.36E-04 | 0.829 | 4.69E-11 |
| 31.17 | 1.0514 | 106.7 | 1.56E-04 | 0.720 | 3.12E-11 | 2.44E-04 | 0.833 | 4.86E-11 |
| 41.29 | 1.0649 | 110.9 | 1.50E-04 | 0.712 | 3.02E-11 | 2.36E-04 | 0.824 | 4.73E-11 |
| 50.56 | 1.0790 | 118.1 | 1.41E-04 | 0.715 | 2.85E-11 | 2.21E-04 | 0.827 | 4.46E-11 |
| 60.11 | 1.0955 | 143.2 | 1.16E-04 | 0.705 | 2.37E-11 | 1.83E-04 | 0.816 | 3.74E-11 |
| 69.74 | 1.1159 | 149.1 | 1.12E-04 | 0.722 | 2.30E-11 | 1.74E-04 | 0.835 | 3.58E-11 |
| 79.04 | 1.1409 | 189.7 | 8.79E-05 | 0.740 | 1.83E-11 | 1.35E-04 | 0.855 | 2.82E-11 |
| 89.36 | 1.1832 | 252.8 | 6.59E-05 | 0.815 | 1.40E-11 | 9.73E-05 | 0.939 | 2.07E-11 |
| 96.50 | 1.2705 | 459.4 | 3.63E-05 | 0.890 | 7.90E-12 | 5.17E-05 | 1.023 | 1.13E-11 |
| 89.66 | 1.2178 | 129.9 | 1.28E-04 | 0.974 | 2.73E-11 | 1.77E-04 | 1.116 | 3.78E-11 |
| 79.40 | 1.1775 | 186.7 | 8.93E-05 | 0.773 | 1.86E-11 | 1.35E-04 | 0.892 | 2.81E-11 |
| 70.17 | 1.1493 | 185.4 | 8.99E-05 | 0.687 | 1.85E-11 | 1.44E-04 | 0.795 | 2.95E-11 |
| 60.68 | 1.1251 | 141.9 | 1.17E-04 | 0.681 | 2.39E-11 | 1.88E-04 | 0.789 | 3.84E-11 |
| 51.21 | 1.1047 | 147.3 | 1.13E-04 | 0.697 | 2.29E-11 | 1.79E-04 | 0.807 | 3.62E-11 |
| 41.88 | 1.0871 | 122.6 | 1.36E-04 | 0.674 | 2.73E-11 | 2.19E-04 | 0.781 | 4.40E-11 |
| 31.59 | 1.0698 | 105.1 | 1.59E-04 | 0.704 | 3.16E-11 | 2.50E-04 | 0.815 | 4.99E-11 |
| 21.52 | 1.0517 | 102.1 | 1.63E-04 | 0.720 | 3.24E-11 | 2.55E-04 | 0.833 | 5.06E-11 |
| 10.82 | 1.0310 | 108.2 | 1.54E-04 | 0.728 | 3.04E-11 | 2.39E-04 | 0.842 | 4.72E-11 |
| 0.00 | 0.9993 | 203.6 | 8.19E-05 | 0.705 | 1.61E-11 | 1.29E-04 | 0.816 | 2.53E-11 |

Figure SI-8. DVS adsorption/desorption experiment for the disk3-T. The green lines are the fitting curves following the Ritger-Peppas (RP) model.

Table SI-6. Ritger-Peppas fitting parameters (($m/m_{dry})_{eq}$, $\tau_{rp}$, $n_{rp}$), the corresponding kinetic constant ($k_{rp}$) and diffusion parameter ($D_{rp}$), the equivalent kinetic constant ($k'$), and diffusion coefficient ($D'$) for each adsorption/desorption step in the DVS experiment for the disk3-T.

| RH [%] | $(m/m_{dry})_{eq}$ | $\tau_{rp}$ [min] | $k_{rp}$ [s$^{-1}$] | n | $D_{rp}$ [m²/s] | $k'$ [s$^{-1}$] | $\beta'$ | $D'$ [m²/s] |
|---|---|---|---|---|---|---|---|---|
| 10.80 | 1.0208 | 84.79 | 1.97E-04 | 0.791 | 4.22E-11 | 2.94E-04 | 0.912 | 6.31E-11 |
| 21.31 | 1.0361 | 91.61 | 1.82E-04 | 0.729 | 3.95E-11 | 2.82E-04 | 0.843 | 6.12E-11 |
| 31.19 | 1.0494 | 96.56 | 1.73E-04 | 0.717 | 3.78E-11 | 2.70E-04 | 0.829 | 5.90E-11 |
| 41.29 | 1.0625 | 105.7 | 1.58E-04 | 0.702 | 3.48E-11 | 2.49E-04 | 0.813 | 5.50E-11 |
| 50.56 | 1.0766 | 123.7 | 1.35E-04 | 0.702 | 3.01E-11 | 2.13E-04 | 0.813 | 4.75E-11 |
| 60.13 | 1.0918 | 145.0 | 1.15E-04 | 0.690 | 2.60E-11 | 1.83E-04 | 0.799 | 4.14E-11 |
| 69.72 | 1.1102 | 139.2 | 1.20E-04 | 0.712 | 2.74E-11 | 1.88E-04 | 0.823 | 4.30E-11 |
| 78.90 | 1.1319 | 176.9 | 9.42E-05 | 0.723 | 2.20E-11 | 1.47E-04 | 0.836 | 3.43E-11 |
| 89.20 | 1.1748 | 281.4 | 5.92E-05 | 0.797 | 1.43E-11 | 8.82E-05 | 0.919 | 2.12E-11 |
| 96.50 | 1.2636 | 386.1 | 4.32E-05 | 0.937 | 1.07E-11 | 6.04E-05 | 1.076 | 1.50E-11 |
| 89.48 | 1.2132 | 129.9 | 1.28E-04 | 0.977 | 3.09E-11 | 1.77E-04 | 1.120 | 4.27E-11 |
| 79.21 | 1.1743 | 197.4 | 8.44E-05 | 0.745 | 1.97E-11 | 1.30E-04 | 0.860 | 3.03E-11 |
| 70.09 | 1.1440 | 243.5 | 6.85E-05 | 0.630 | 1.57E-11 | 1.14E-04 | 0.732 | 2.63E-11 |
| 60.63 | 1.1230 | 158.4 | 1.05E-04 | 0.632 | 2.38E-11 | 1.76E-04 | 0.734 | 3.97E-11 |
| 51.18 | 1.1028 | 154.5 | 1.08E-04 | 0.658 | 2.41E-11 | 1.76E-04 | 0.764 | 3.93E-11 |
| 41.85 | 1.0847 | 122.2 | 1.36E-04 | 0.677 | 3.02E-11 | 2.19E-04 | 0.784 | 4.85E-11 |
| 31.57 | 1.0672 | 110.2 | 1.51E-04 | 0.698 | 3.31E-11 | 2.40E-04 | 0.808 | 5.25E-11 |
| 21.48 | 1.0493 | 106.7 | 1.56E-04 | 0.702 | 3.39E-11 | 2.47E-04 | 0.813 | 5.35E-11 |
| 10.77 | 1.0287 | 109.4 | 1.52E-04 | 0.720 | 3.27E-11 | 2.38E-04 | 0.832 | 5.10E-11 |
| 0.00 | 0.9977 | 190.2 | 8.76E-05 | 0.703 | 1.86E-11 | 1.38E-04 | 0.814 | 2.94E-11 |
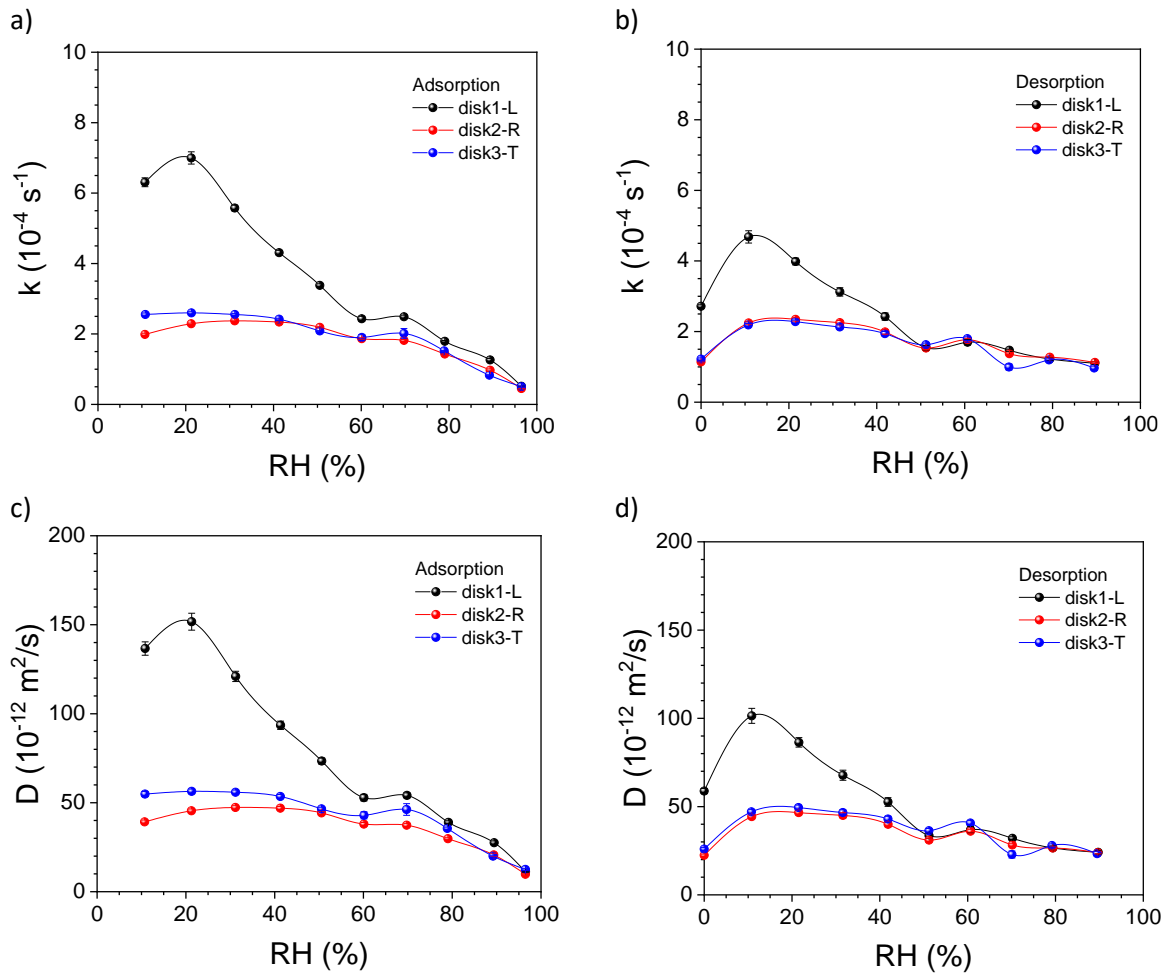
Figure SI-9. a) Adsorption and b) desorption kinetic constant (k), and c) adsorption and d) desorption diffusion coefficient (D) using the DSE model for the three beech disks: disk1-L, disk2-R and disk3-T.
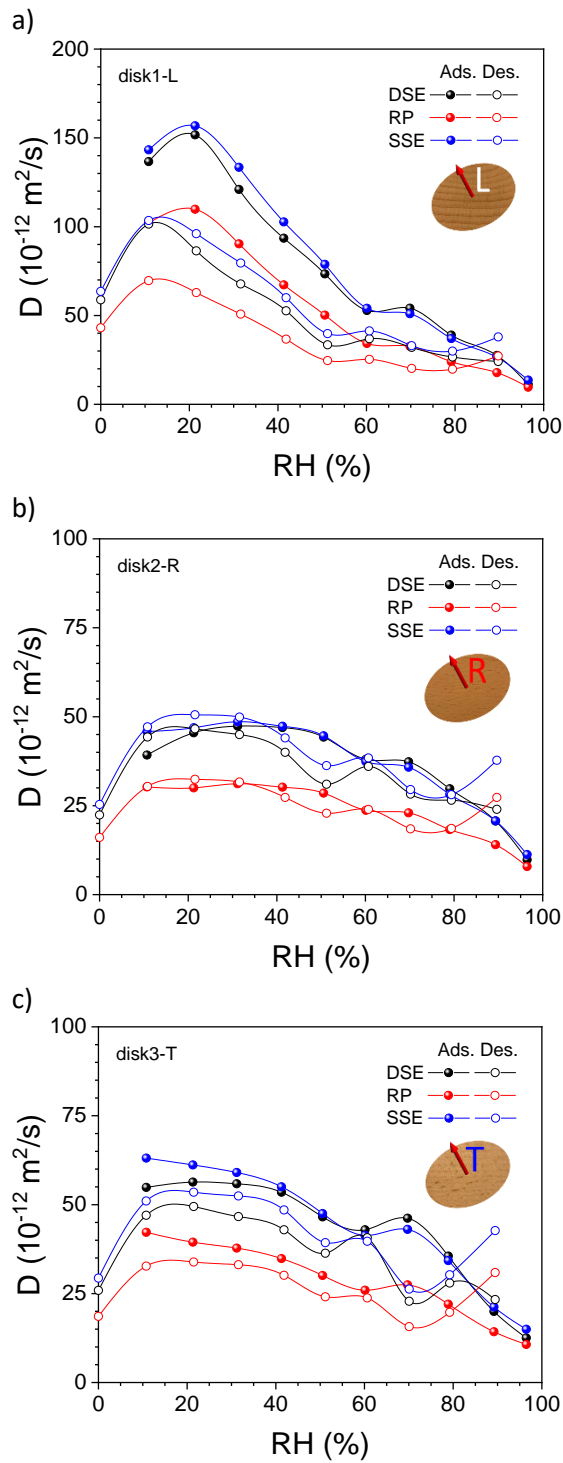
Figure SI-10. Adsorption/desorption diffusion coefficient (D) as a function of the relative humidity for the three beech disks: a) disk1-L, b) disk-R, and c) disk3-T, using the double stretched exponential (DSE) model, the Ritger-Peppas (RP) model and the equivalent to the single stretched exponential function (SSE) from the Ritger-Peppas model.
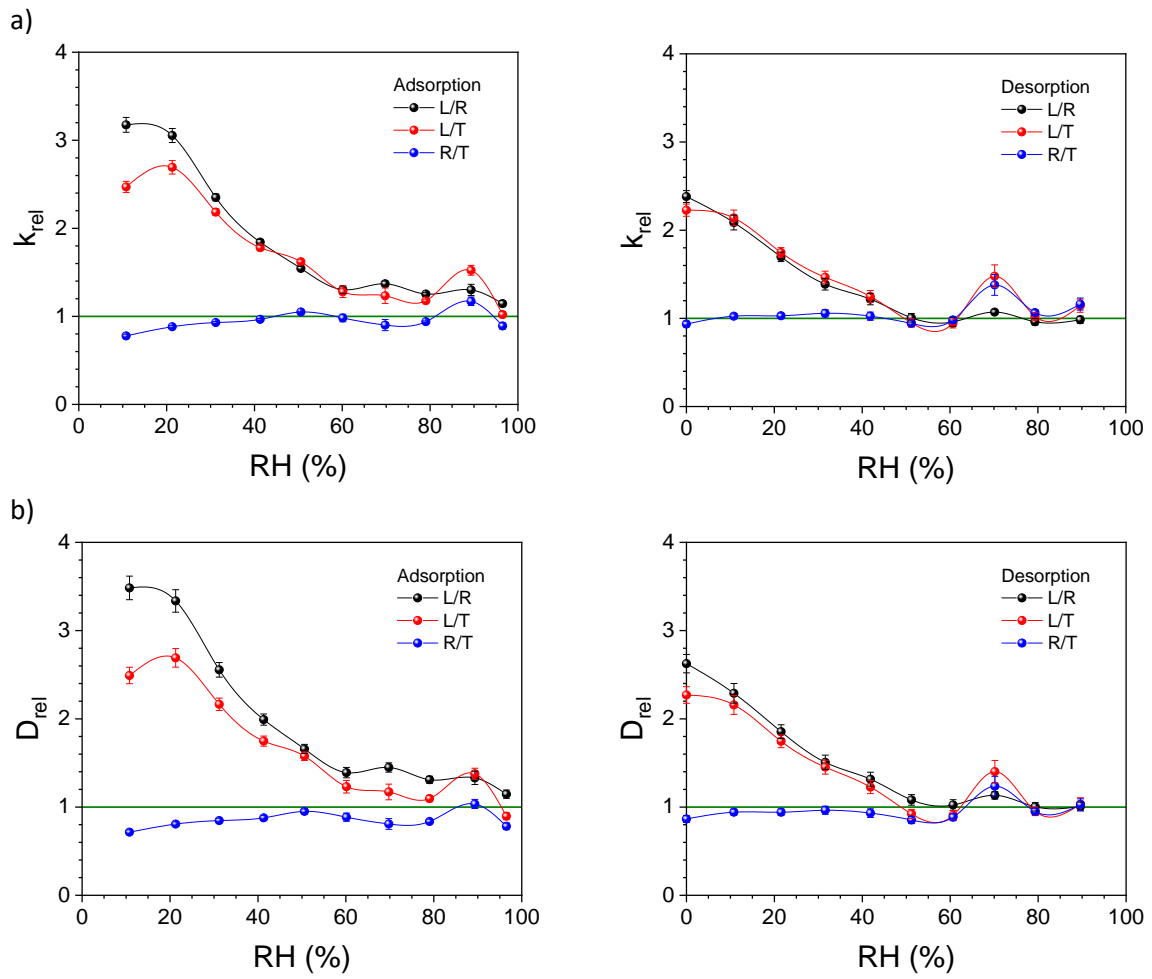
Figure SI-11. a) Adsorption and c) desorption relative directional kinetic constant ($k_{rel}$: L/R, L/T and R/T), and c) adsorption and d) desorption relative directional diffusion coefficient ($D_{rel}$: L/R, L/T and R/T) for the three beech disks: disk1-L, disk2-R and disk3-T.
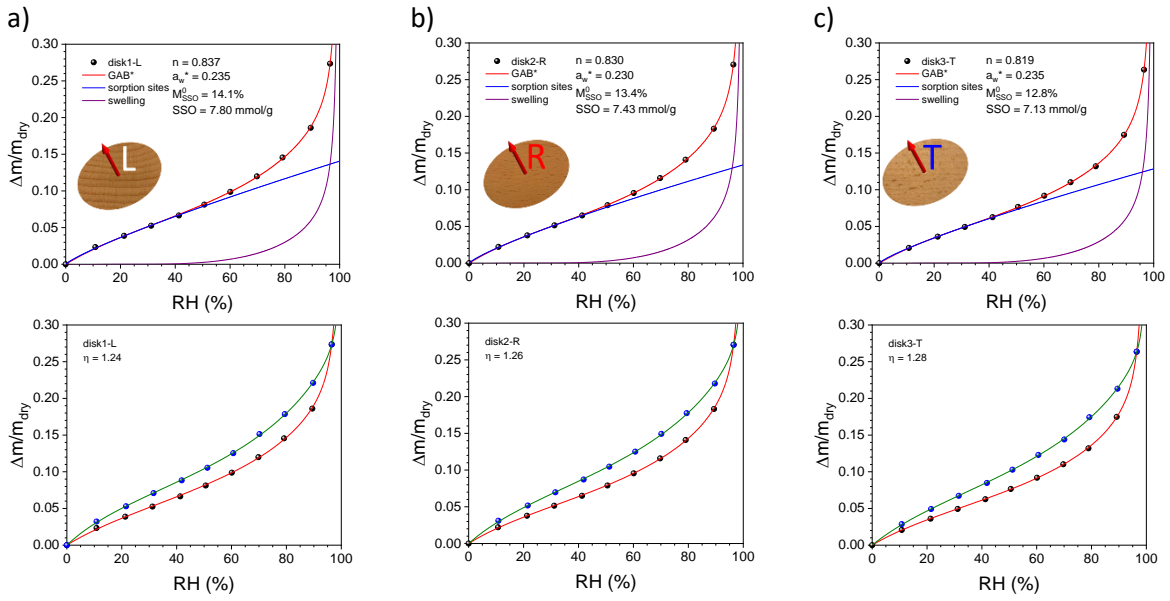
Figure SI-12. (Top) Moisture adsorption isotherm, fitting of the data following the GAB* model ($0 \leq a_w \leq 0.99$), and deconvolution following the SSO model (bound water, blue; non-bound water violet). (Bottom) Both the moisture adsorption (red) and desorption (green) isotherms and the corresponding hysteresis factor $\eta$ for the three beech disks: a) disk1-L ($\eta = 1.24$), b) disk2-R ($\eta = 1.26$), and c) disk3-T ($\eta = 1.28$).

Table SI-7. GAB* fitting parameters ($M_0$, C, K and N), the SSO fitting parameters: exponent (n), the maximum bound water moisture capacity ($M_{SSO}^0$), and the sorption sites molar concentration (SSO) for the three beech disks.

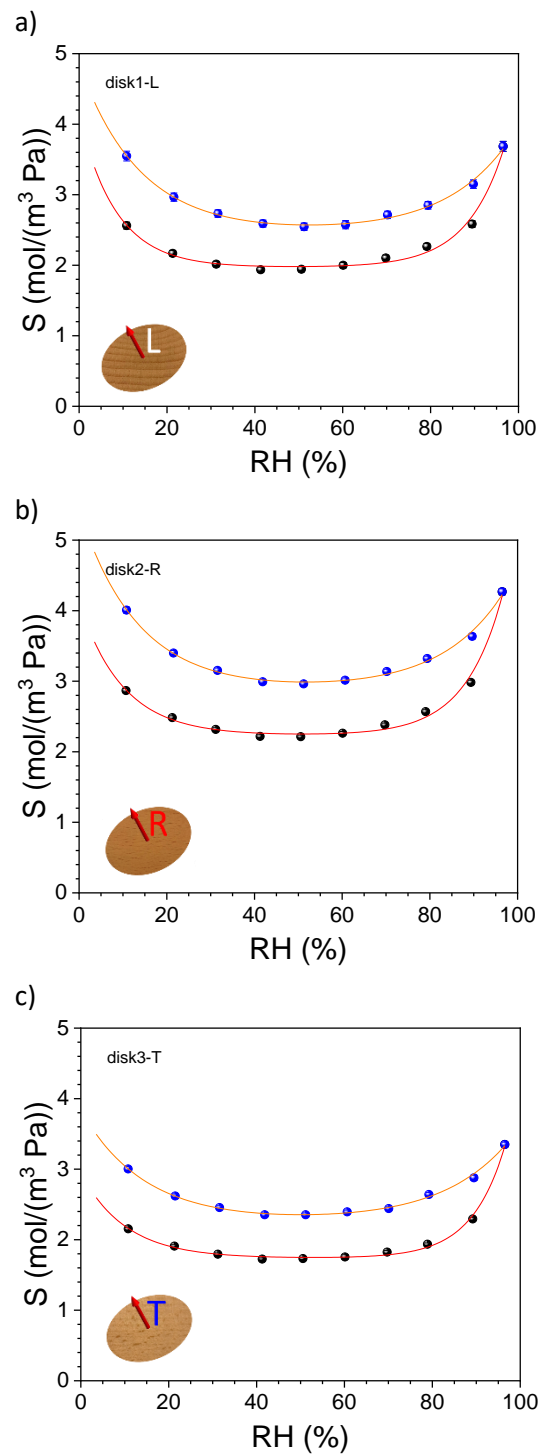|         | $M_0$  | C    | K     | N       | n     | $M_{SSO}^0$ | SSO [mmol/g] |
|---------|--------|------|-------|---------|-------|-------------|--------------|
| disk1-L | 0.0773 | 4.47 | 0.670 | 0.00447 | 0.837 | 0.141       | 7.80         |
| disk2-R | 0.0712 | 4.76 | 0.692 | 0.00407 | 0.830 | 0.134       | 7.43         |
| disk3-T | 0.0695 | 4.76 | 0.677 | 0.00484 | 0.819 | 0.128       | 7.13         |

Figure SI-13. Sorption coefficient (S) profile in the adsorption (red curve) and desorption (orange curve) process for the three beech disks: a) disk1-L, b) disk2-R, and c) disk3-T.

Table SI-8. Sorption coefficient (S) calculated from the moisture sorption isotherms for the three beech disks: disk1-L, disk2-R, and disk3-T.

| disk1-L | | disk2-R | | disk3-T | |
|---|---|---|---|---|---|
| RH (%) | S [mol/(m$^3$ Pa)] | RH (%) | S [mol/(m$^3$ Pa)] | RH (%) | S [mol/(m$^3$ Pa)] |
| 10.8 | 2.57 | 10.7 | 2.87 | 10.8 | 2.18 |
| 21.3 | 2.18 | 21.3 | 2.48 | 21.3 | 1.94 |
| 31.2 | 2.03 | 31.2 | 2.32 | 31.2 | 1.82 |
| 41.3 | 1.95 | 41.3 | 2.22 | 41.3 | 1.75 |
| 50.6 | 1.95 | 50.6 | 2.21 | 50.6 | 1.76 |
| 60.1 | 2.01 | 60.1 | 2.26 | 60.1 | 1.78 |
| 69.8 | 2.11 | 69.7 | 2.38 | 69.7 | 1.85 |
| 79.2 | 2.28 | 79.0 | 2.57 | 78.9 | 1.96 |
| 89.5 | 2.60 | 89.4 | 2.98 | 89.2 | 2.32 |
| 96.5 | 3.70 | 96.5 | 4.27 | 96.5 | 3.39 |
| 89.8 | 3.17 | 89.7 | 3.63 | 89.5 | 2.92 |
| 79.4 | 2.86 | 79.4 | 3.32 | 79.2 | 2.68 |
| 70.2 | 2.73 | 70.2 | 3.14 | 70.1 | 2.47 |
| 60.7 | 2.59 | 60.7 | 3.01 | 60.6 | 2.43 |
| 51.2 | 2.56 | 51.2 | 2.96 | 51.2 | 2.39 |
| 41.9 | 2.60 | 41.9 | 2.99 | 41.9 | 2.38 |
| 31.6 | 2.75 | 31.6 | 3.15 | 31.6 | 2.49 |
| 21.6 | 2.98 | 21.5 | 3.40 | 21.5 | 2.66 |
| 10.8 | 3.57 | 10.8 | 4.01 | 10.8 | 3.04 |

Figure SI-14. Moisture transmission experiments on the three beech disks under different conditions: inner RH-value of 100% against outer RH-value of a) 0% and b) 65%; inner RH-value of 0% against outer RH-value of c) 65% and d) 100%. The lines are the fits to the experimental data using the exponential-linear fitting function (Eq. 4).
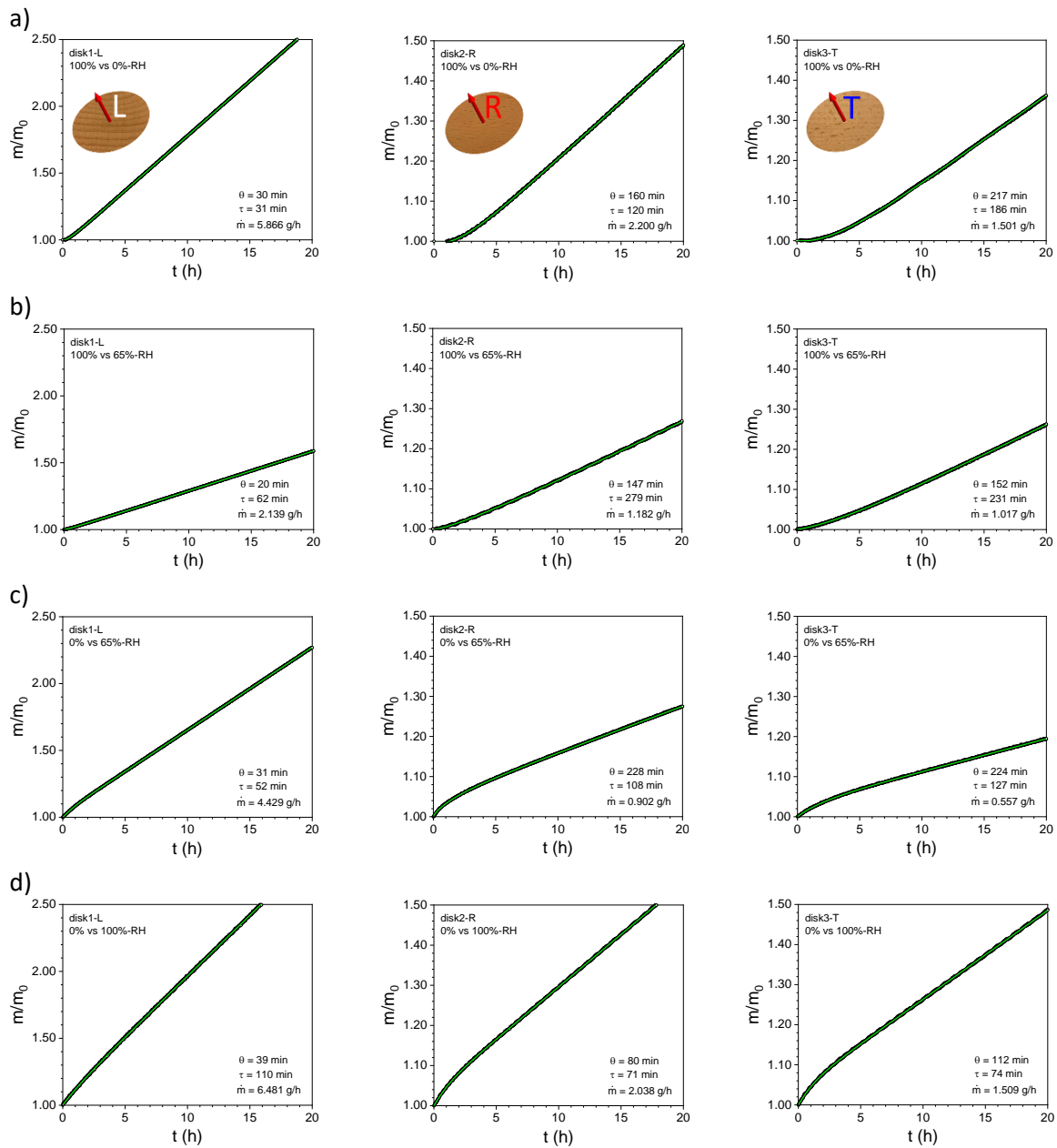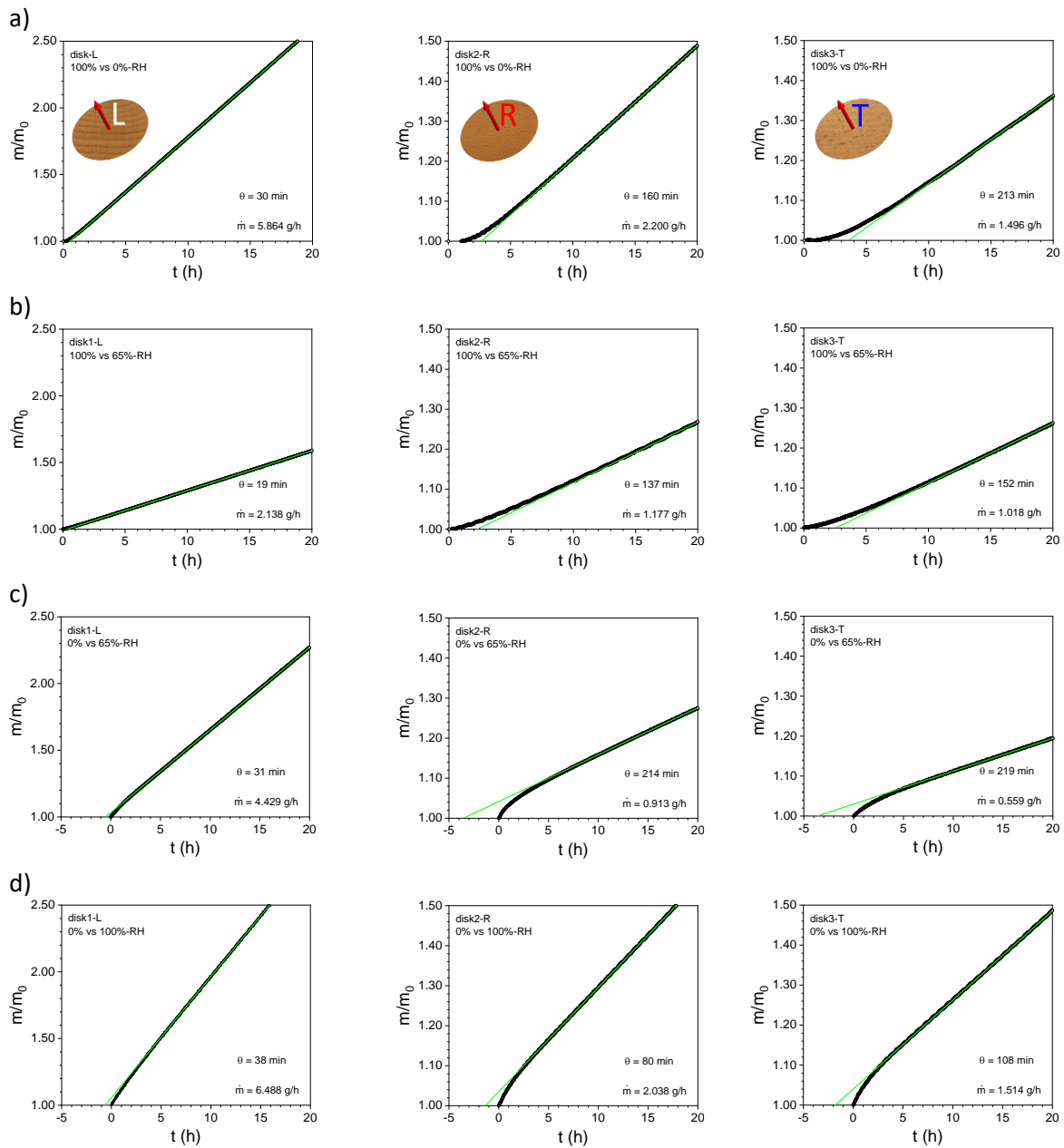
Figure SI-15. Moisture transmission experiments on the three beech disks under different conditions: inner RH-value of 100% against outer RH-value of a) 0% and b) 65%; inner RH-value of 0% against outer RH-value of c) 65% and d) 100%. The lines are linear fits to the experimental data in the linear regime.

Table SI-9. Permeability coefficient (P), transmission rate (TR), mass rate ($\dot{m}$), diffusion coefficient ($D_\theta$, $D_\tau$, $D_{MSI}$), sorption coefficient ($S_\theta$, $S_\tau$, $S_{MSI}$), lagtime ($\theta$), lifetime ($\tau$), stretched exponential factor ($\beta$), and moisture capacity ($M_w$) at different relative humidity conditions for the disk1-L.

| | 100% vs 0%-RH | 100% vs 65%-RH | 0% vs 65%-RH | 0% vs 100%-RH |
|---|---|---|---|---|
| $\Delta p$ [Pa] | 2862 | 1002 | 1860 | 2862 |
| P [mol/(m s Pa)] | $(3.66 \pm 0.04)\ 10^{-10}$ | $(3.87 \pm 0.04)\ 10^{-10}$ | $(4.38 \pm 0.04)\ 10^{-10}$ | $(4.04 \pm 0.04)\ 10^{-10}$ |
| TR [mol/(m$^2$ s)] | $(9.95 \pm 0.02)\ 10^{-4}$ | $(3.69 \pm 0.01)\ 10^{-4}$ | $(7.76 \pm 0.01)\ 10^{-4}$ | $(11.00 \pm 0.02)\ 10^{-4}$ |
| $\dot{m}$ [mol/s] | $(9.044 \pm 0.001)\ 10^{-8}$ | $(3.298 \pm 0.001)\ 10^{-8}$ | $(6.829 \pm 0.001)\ 10^{-8}$ | $(9.993 \pm 0.001)\ 10^{-8}$ |
| $D_\theta$ [m$^2$/s] | $(1.01 \pm 0.02)\ 10^{-10}$ | $(1.54 \pm 0.10)\ 10^{-10}$ | $(0.97 \pm 0.03)\ 10^{-10}$ | $(0.78 \pm 0.03)\ 10^{-10}$ |
| $D_\tau$ [m$^2$/s] | $(4.72 \pm 0.10)\ 10^{-10}$ | $(2.32 \pm 0.20)\ 10^{-10}$ | $(2.79 \pm 0.10)\ 10^{-10}$ | $(1.32 \pm 0.10)\ 10^{-10}$ |
| $D_{MSI}$ [m$^2$/s] | $(1.6 \pm 0.1)\ 10^{-10}$ | $(1.6 \pm 0.1)\ 10^{-10}$ | $(2.0 \pm 0.2)\ 10^{-10}$ | $(1.8 \pm 0.1)\ 10^{-10}$ |
| $S_\theta$ [mol/(m$^3$ Pa)] | $3.6 \pm 0.1$ | $2.5 \pm 0.2$ | $4.5 \pm 0.1$ | $5.2 \pm 0.2$ |
| $S_\tau$ [mol/(m$^3$ Pa)] | $0.77 \pm 0.03$ | $1.7 \pm 0.1$ | $1.57 \pm 0.05$ | $3.1 \pm 0.1$ |
| $S_{MSI}$ [mol/(m$^3$ Pa)] | $2.25 \pm 0.05$ | $2.39 \pm 0.05$ | $2.16 \pm 0.04$ | $2.25 \pm 0.05$ |
| $\theta$ [min] | $30 \pm 1$ | $20 \pm 1$ | $31 \pm 1$ | $39 \pm 1$ |
| $\tau$ [min] | $31 \pm 1$ | $62 \pm 5$ | $52 \pm 1$ | $110 \pm 3$ |
| $\beta$ | $0.80 \pm 0.02$ | $0.72 \pm 0.06$ | $1.14 \pm 0.04$ | $0.90 \pm 0.03$ |
| $M_w$ (%) | $4.2 \pm 0.1$ | $1.0 \pm 0.1$ | $3.2 \pm 0.1$ | $5.9 \pm 0.2$ |
| Area (%) | 8.4 | 1.0 | 3.6 | 8.4 |

Table SI-10. Permeability coefficient (P), transmission rate (TR), mass rate ($\dot{m}$), diffusion coefficient ($D_\theta$, $D_\tau$, $D_{MSI}$), sorption coefficient ($S_\theta$, $S_\tau$, $S_{MSI}$), lagtime ($\theta$), lifetime ($\tau$), stretched exponential factor ($\beta$), and moisture capacity ($M_w$) at different relative humidity conditions for the disk2-R.

| | 100% vs 0%-RH | 100% vs 65%-RH | 0% vs 65%-RH | 0% vs 100%-RH |
|---|---|---|---|---|
| $\Delta p$ [Pa] | 2862 | 1002 | 1860 | 2862 |
| P [mol/(m s Pa)] | $(1.35 \pm 0.01)\ 10^{-10}$ | $(2.08 \pm 0.02)\ 10^{-10}$ | $(8.59 \pm 0.09)\ 10^{-11}$ | $(1.25 \pm 0.01)\ 10^{-10}$ |
| TR [mol/(m$^2$ s)] | $(3.80 \pm 0.01)\ 10^{-4}$ | $(2.06 \pm 0.01)\ 10^{-4}$ | $(1.59 \pm 0.01)\ 10^{-4}$ | $(3.52 \pm 0.01)\ 10^{-4}$ |
| $\dot{m}$ [mol/s] | $(3.393 \pm 0.002)\ 10^{-8}$ | $(1.823 \pm 0.001)\ 10^{-8}$ | $(1.391 \pm 0.001)\ 10^{-8}$ | $(3.142 \pm 0.001)\ 10^{-8}$ |
| $D_\theta$ [m$^2$/s] | $(1.80 \pm 0.04)\ 10^{-11}$ | $(1.94 \pm 0.05)\ 10^{-11}$ | $(1.23 \pm 0.03)\ 10^{-11}$ | $(3.59 \pm 0.08)\ 10^{-11}$ |
| $D_\tau$ [m$^2$/s] | $(1.13 \pm 0.02)\ 10^{-10}$ | $(4.81 \pm 0.01)\ 10^{-11}$ | $(1.22 \pm 0.03)\ 10^{-10}$ | $(1.90 \pm 0.04)\ 10^{-10}$ |
| $D_{MSI}$ [m$^2$/s] | $(5.3 \pm 0.3)\ 10^{-11}$ | $(7.6 \pm 0.4)\ 10^{-11}$ | $(3.5 \pm 0.2)\ 10^{-11}$ | $(4.9 \pm 0.2)\ 10^{-11}$ |
| $S_\theta$ [mol/(m$^3$ Pa)] | $7.5 \pm 0.2$ | $10.7 \pm 0.3$ | $7.0 \pm 0.2$ | $3.5 \pm 0.1$ |
| $S_\tau$ [mol/(m$^3$ Pa)] | $1.19 \pm 0.03$ | $4.3 \pm 0.1$ | $0.70 \pm 0.02$ | $0.66 \pm 0.02$ |
| $S_{MSI}$ [mol/(m$^3$ Pa)] | $2.56 \pm 0.03$ | $2.73 \pm 0.03$ | $2.44 \pm 0.03$ | $2.56 \pm 0.03$ |
| $\theta$ [min] | $160 \pm 1$ | $147 \pm 2$ | $228 \pm 2$ | $80 \pm 1$ |
| $\tau$ [min] | $120 \pm 1$ | $279 \pm 5$ | $108 \pm 1$ | $71 \pm 1$ |
| $\beta$ | $0.96 \pm 0.01$ | $0.74 \pm 0.01$ | $0.74 \pm 0.01$ | $1.05 \pm 0.02$ |
| $M_w$ (%) | $7.5 \pm 0.1$ | $3.7 \pm 0.1$ | $4.4 \pm 0.1$ | $3.5 \pm 0.1$ |
| Area (%) | 8.2 | 4.8 | 3.5 | 8.2 |

Table SI-11. Permeability coefficient (P), transmission rate (TR), mass rate ($\dot{m}$), diffusion coefficient ($D_\theta$, $D_\tau$, $D_{MSI}$), sorption coefficient ($S_\theta$, $S_\tau$, $S_{MSI}$), lagtime ($\theta$), lifetime ($\tau$), stretched exponential factor ($\beta$), and moisture capacity ($M_w$) at different relative humidity conditions for the disk3-T.

| | 100% vs 0%-RH | 100% vs 65%-RH | 0% vs 65%-RH | 0% vs 100%-RH |
|---|---|---|---|---|
| $\Delta p$ [Pa] | 2862 | 1002 | 1860 | 2862 |
| P [mol/(m s Pa)] | $(0.98 \pm 0.01)\ 10^{-10}$ | $(1.89 \pm 0.02)\ 10^{-10}$ | $(5.57 \pm 0.05)\ 10^{-11}$ | $(0.99 \pm 0.01)\ 10^{-10}$ |
| TR [mol/(m$^2$ s)] | $(2.62 \pm 0.01)\ 10^{-4}$ | $(1.79 \pm 0.01)\ 10^{-4}$ | $(0.99 \pm 0.01)\ 10^{-4}$ | $(2.63 \pm 0.01)\ 10^{-4}$ |
| $\dot{m}$ [mol/s] | $(2.315 \pm 0.002)\ 10^{-8}$ | $(1.568 \pm 0.002)\ 10^{-8}$ | $(0.859 \pm 0.001)\ 10^{-8}$ | $(2.327 \pm 0.001)\ 10^{-8}$ |
| $D_\theta$ [m$^2$/s] | $(1.47 \pm 0.03)\ 10^{-11}$ | $(2.05 \pm 0.04)\ 10^{-11}$ | $(1.37 \pm 0.03)\ 10^{-11}$ | $(2.86 \pm 0.06)\ 10^{-11}$ |
| $D_\tau$ [m$^2$/s] | $(8.10 \pm 0.20)\ 10^{-11}$ | $(6.38 \pm 0.20)\ 10^{-11}$ | $(1.13 \pm 0.02)\ 10^{-10}$ | $(2.04 \pm 0.05)\ 10^{-10}$ |
| $D_{MSI}$ [m$^2$/s] | $(5.0 \pm 0.2)\ 10^{-11}$ | $(9.0 \pm 0.4)\ 10^{-11}$ | $(3.0 \pm 0.1)\ 10^{-11}$ | $(5.0 \pm 0.2)\ 10^{-11}$ |
| $S_\theta$ [mol/(m$^3$ Pa)] | $6.7 \pm 0.1$ | $9.2 \pm 0.2$ | $4.1 \pm 0.1$ | $3.4 \pm 0.1$ |
| $S_\tau$ [mol/(m$^3$ Pa)] | $1.21 \pm 0.03$ | $3.0 \pm 0.1$ | $0.49 \pm 0.01$ | $0.48 \pm 0.01$ |
| $S_{MSI}$ [mol/(m$^3$ Pa)] | $1.96 \pm 0.02$ | $2.10 \pm 0.03$ | $1.88 \pm 0.02$ | $1.96 \pm 0.02$ |
| $\theta$ [min] | $217 \pm 1$ | $152 \pm 1$ | $224 \pm 2$ | $112 \pm 1$ |
| $\tau$ [min] | $186 \pm 1$ | $231 \pm 4$ | $127 \pm 1$ | $74 \pm 1$ |
| $\beta$ | $1.02 \pm 0.01$ | $1.00 \pm 0.01$ | $0.94 \pm 0.01$ | $1.06 \pm 0.02$ |
| $M_w$ (%) | $8.0 \pm 0.1$ | $3.8 \pm 0.1$ | $3.1 \pm 0.1$ | $4.1 \pm 0.1$ |
| Area (%) | 7.9 | 4.5 | 3.3 | 7.9 |
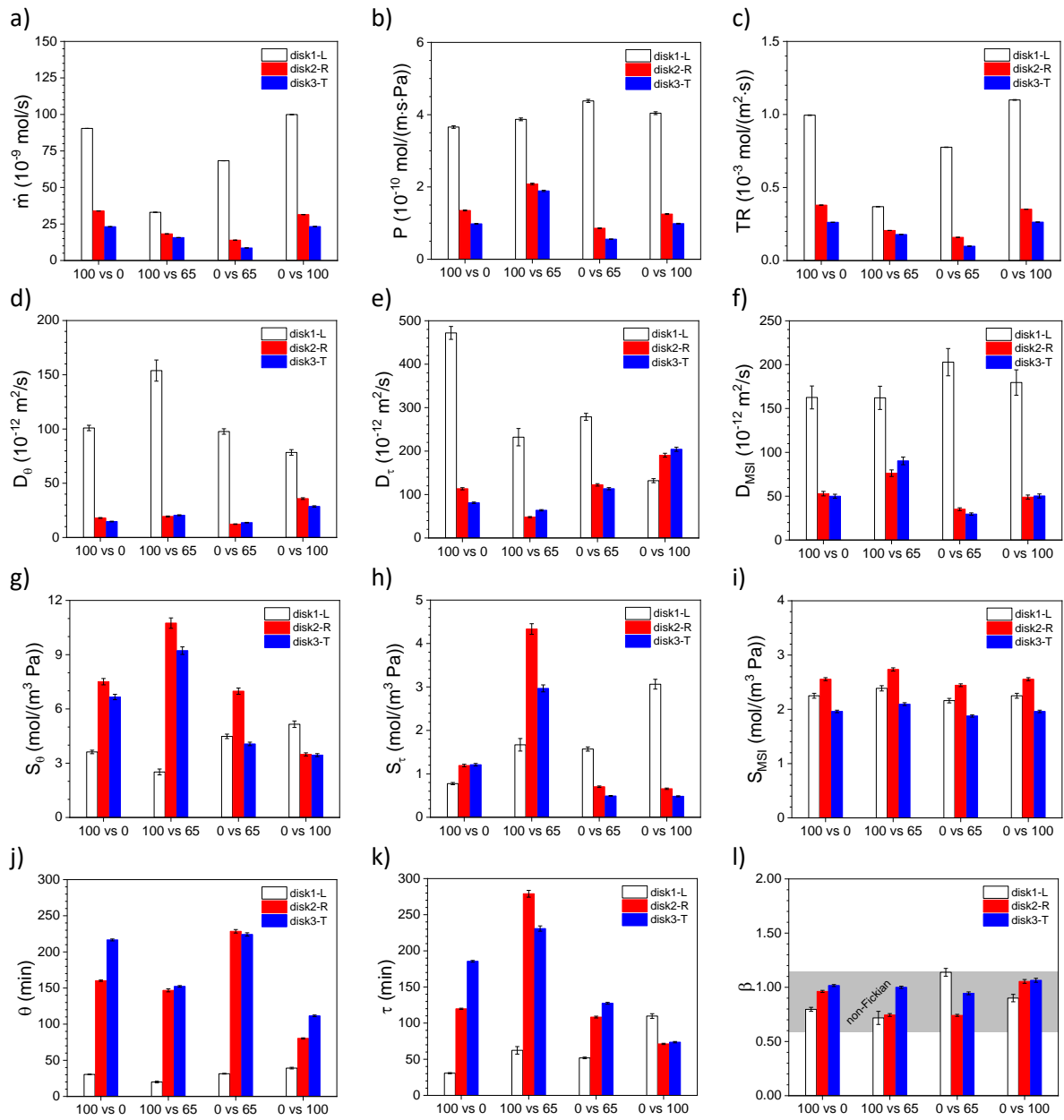
Figure SI-16. a) Mass rate ($\dot{m}$), b) transmission rate (TR), c) permeability coefficient (P), d,e,f) diffusion coefficient ($D_\theta$, $D_\tau$, $D_{MSI}$), g,h,i) sorption coefficient ($S_\theta$, $S_\tau$, $S_{MSI}$), j) lagtime ($\theta$), k) lifetime ($\tau$), and l) stretched exponential factor ($\beta$) for the three beech disks with the moisture transmission parallel to the longitudinal (L), radial (R), and tangential (T) direction at different relative humidity conditions. Note: in the x-axis, the first value refers to the inner RH-value (cup) and the second one to the outer RH-value (gas flow).
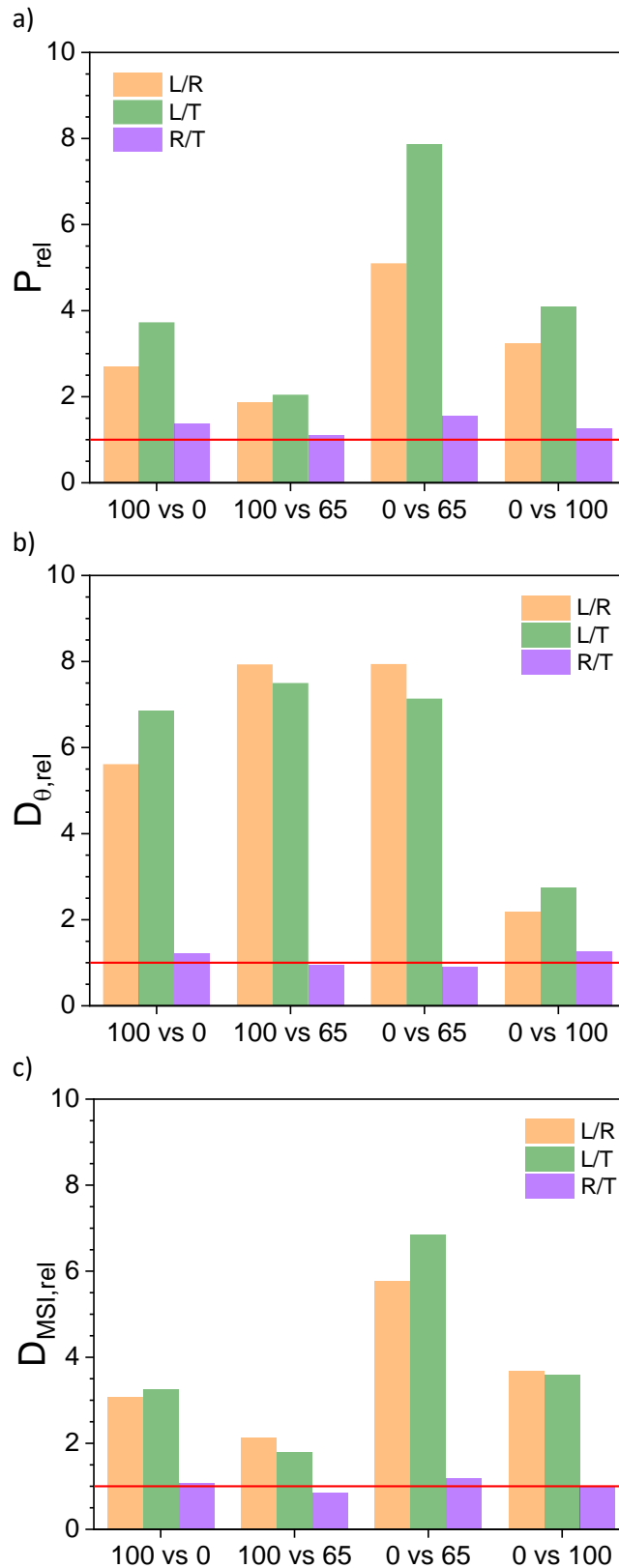
Figure SI-17. a) Relative directional permeability coefficient ($P_{rel}$: L/R, L/T and R/T), b) relative directional diffusion coefficient obtained from the lagtime value θ ($D_\theta$: L/R, L/T and R/T), and c) relative diffusion coefficient obtained from the moisture sorption isotherms ($D_{MSI}$: L/R, L/T and R/T) at different relative humidity conditions for the three beech disks: disk1-L, disk2-R and disk3-T. Note: in the x-axis, the first value refers to the inner RH-value (cup) and the second one to the outer RH-value (gas flow).
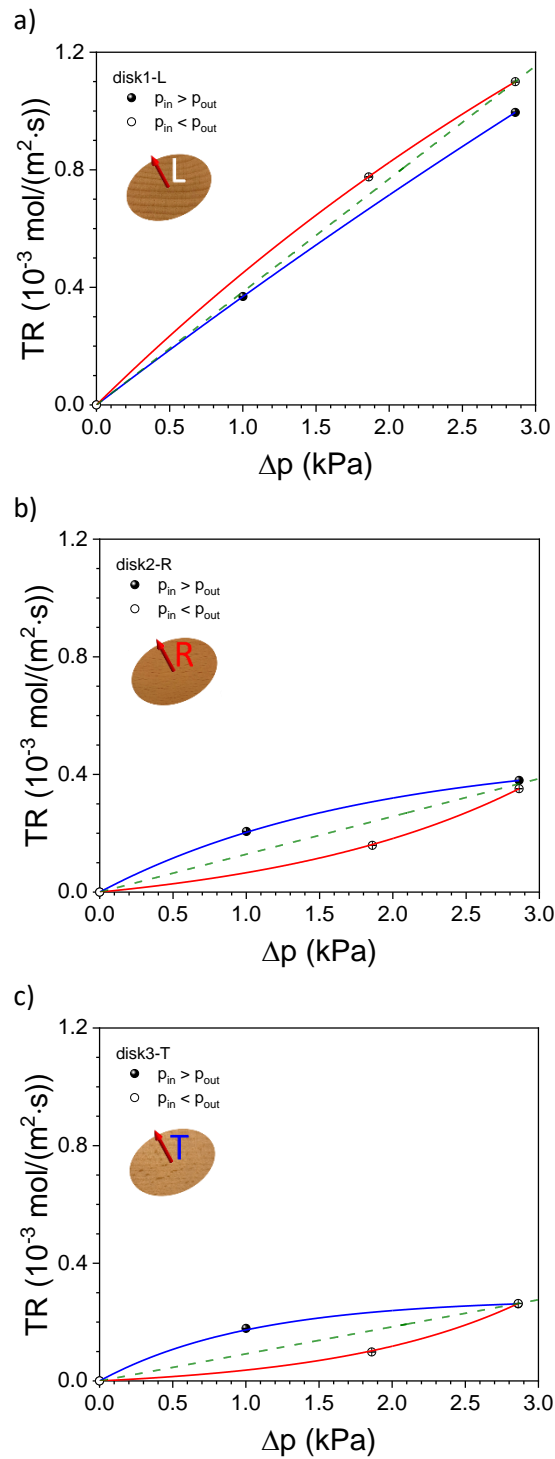
Figure SI-18. Transmission rate (TR) as a function of the vapor pressure difference at different relative humidity conditions for the three beech disks: disk1-L, disk2-R and disk3-T. Note: the green curve is representing the theoretical linear behavior.