SUPPORTING INFORMATION

Exploring Wood as a Sustainable Solution for Water Filtration: Nanoparticle Removal, Size Exclusion and Molecular Adsorption

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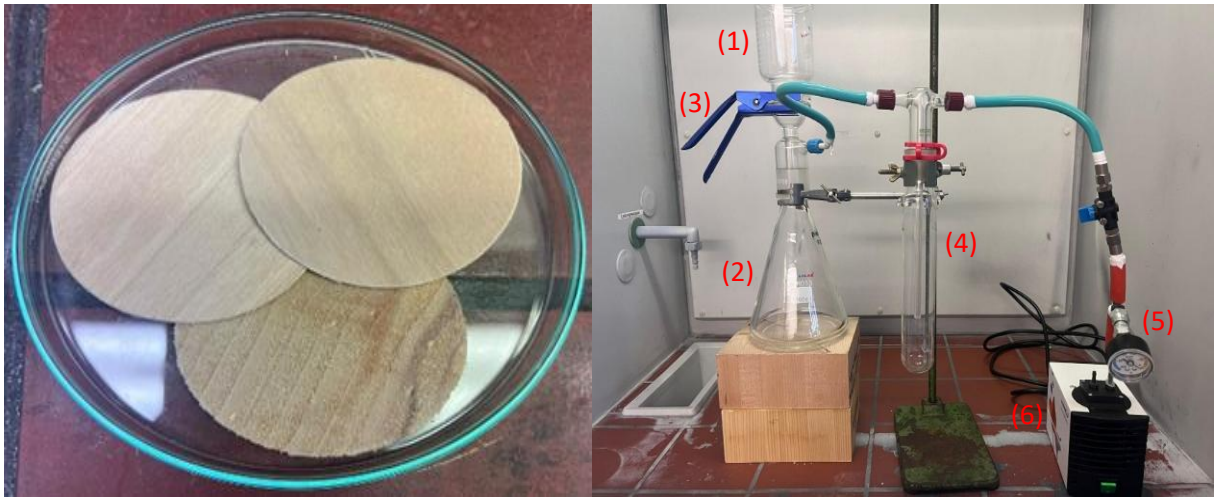


Figure SI-1. Left: Wood filtration disks (50 mm diameter and 1 mm thickness at 20 °C and 65% RH). Right: Setup for the filtration experiments: graduated funnel (1), filter flask (2), aluminum clamp (3), water trap (4), pressure gauge (5), and vacuum membrane pump (6).

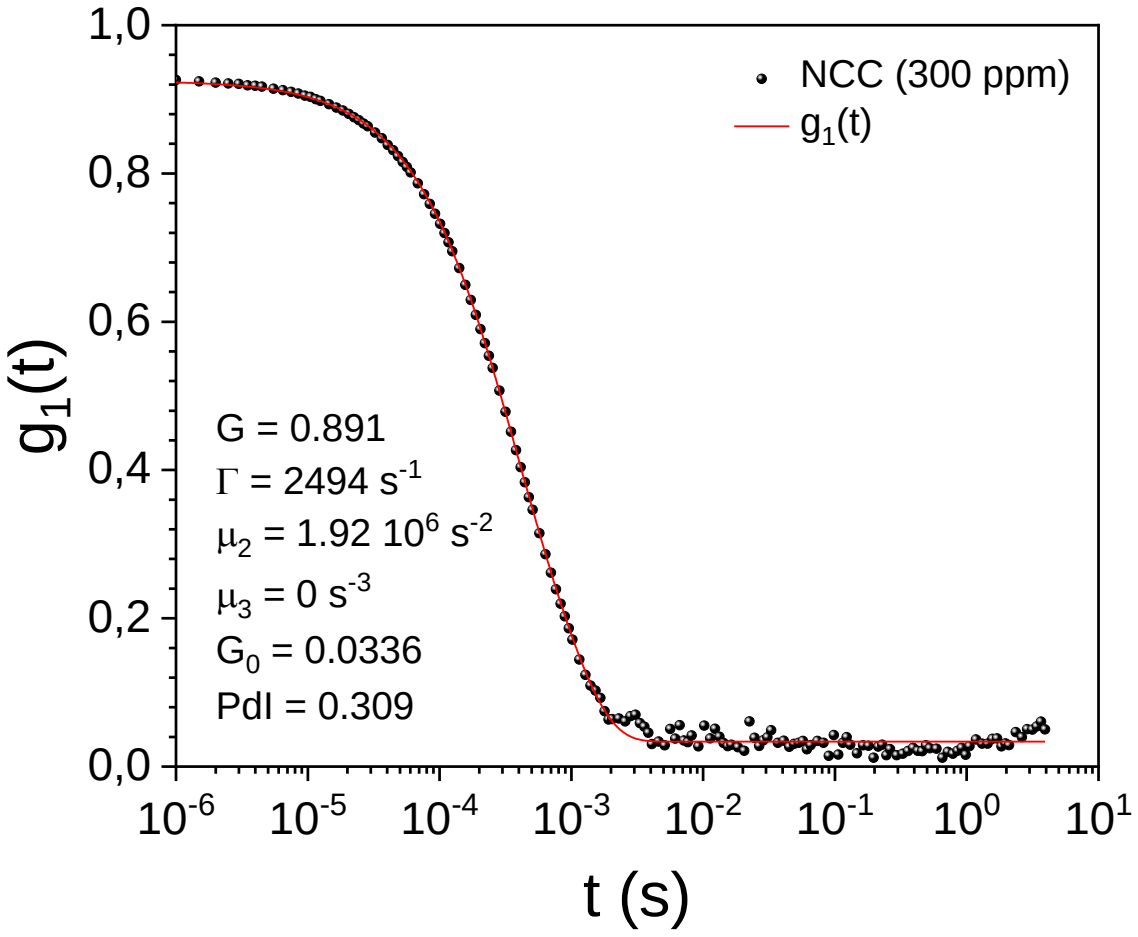


Figure SI-2. DLS data from a 300 ppm NCC dispersion in water (filled symbols), DLS autocorrelation function $g_1(t)$ (red curve), and the parameters obtained after the analysis following the cumulant method for polydisperse samples.

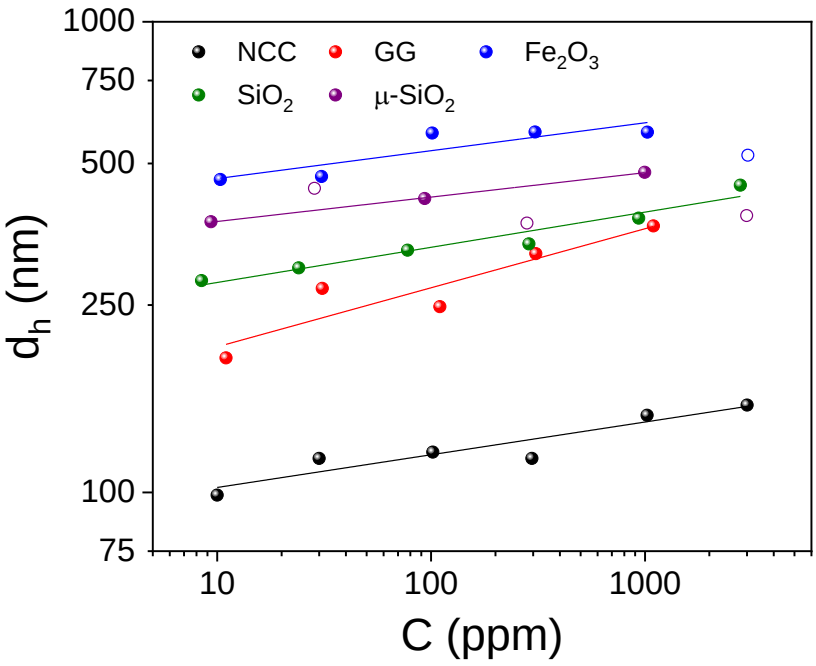


Figure SI-3. Hydrodynamic diameter d_h as a function of particle concentration C for the different tracers: NCC (black), GG (red), Fe_2O_3 (blue), SiO_2 (green) and μ-SiO_2 (violet).

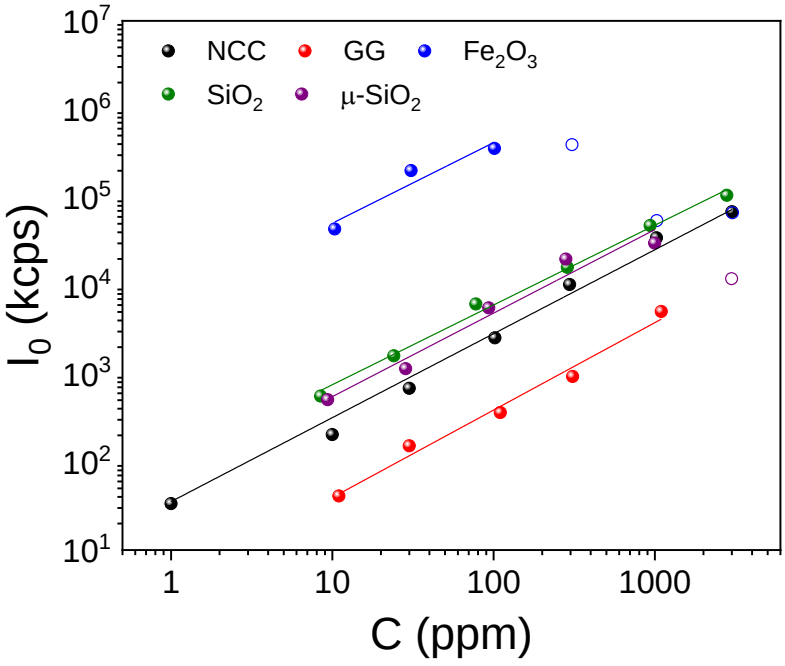


Figure SI-4. Mean count rate I_0 as a function of particle concentration C for the different tracers: NCC (black), GG (red), Fe_2O_3 (blue), SiO_2 (green) and μ-SiO_2 (violet).

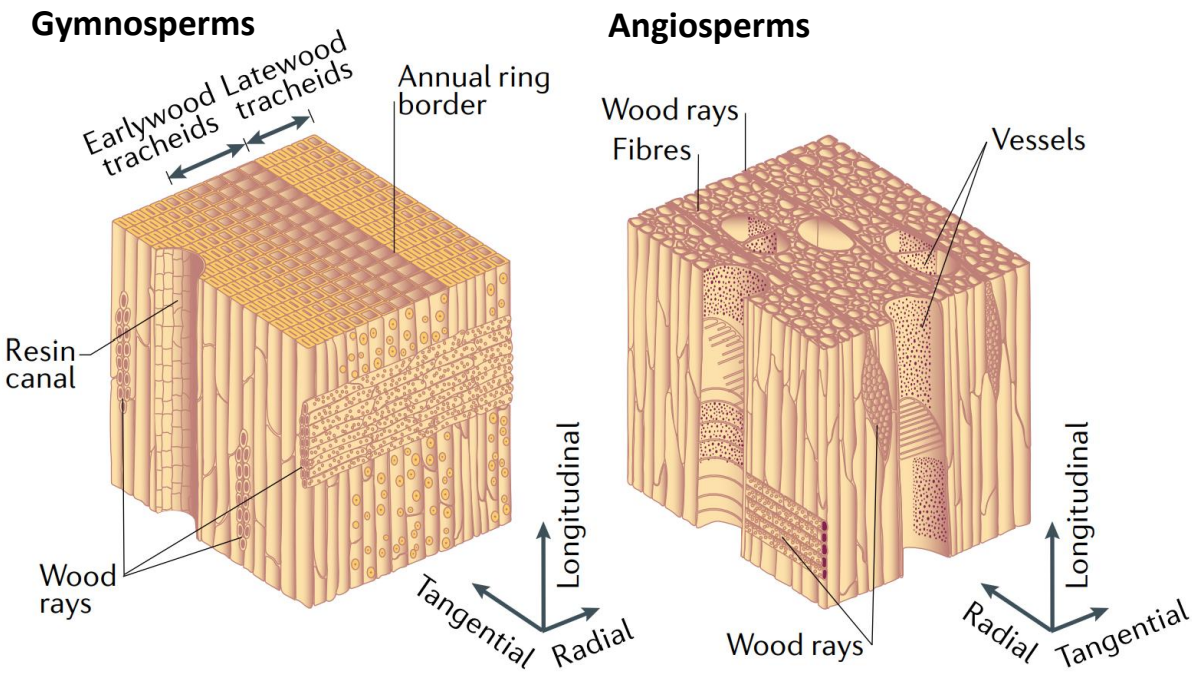


Figure SI-5. Gymnosperms and angiosperms anatomical structure (Chen *et al.*, 2020).

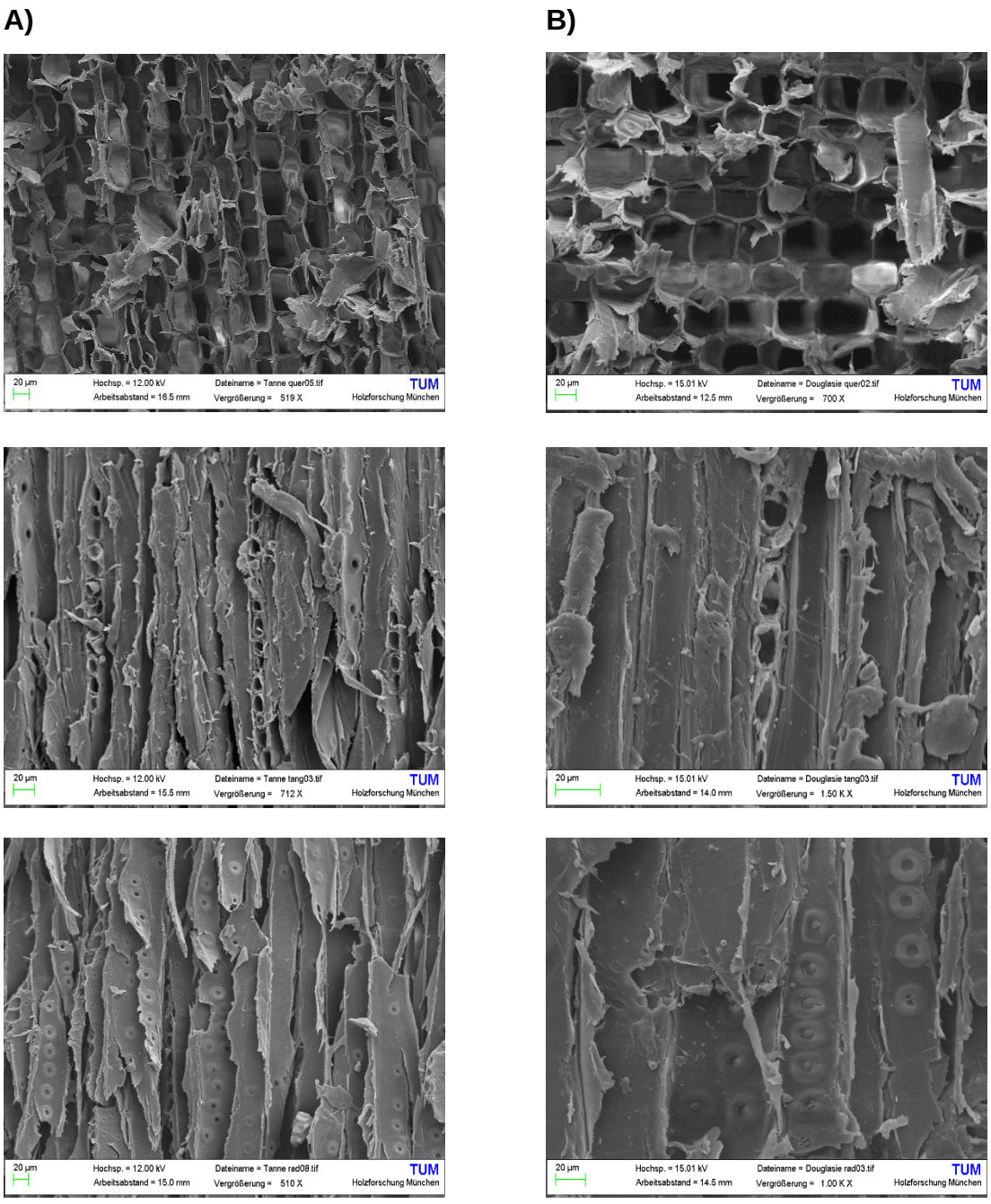


Figure SI-6. Scanning electron microscope image of the two gymnosperm species – A) silver fir and B) Douglas fir in the longitudinal (upper), radial (middle), and tangential (bottom) directions.

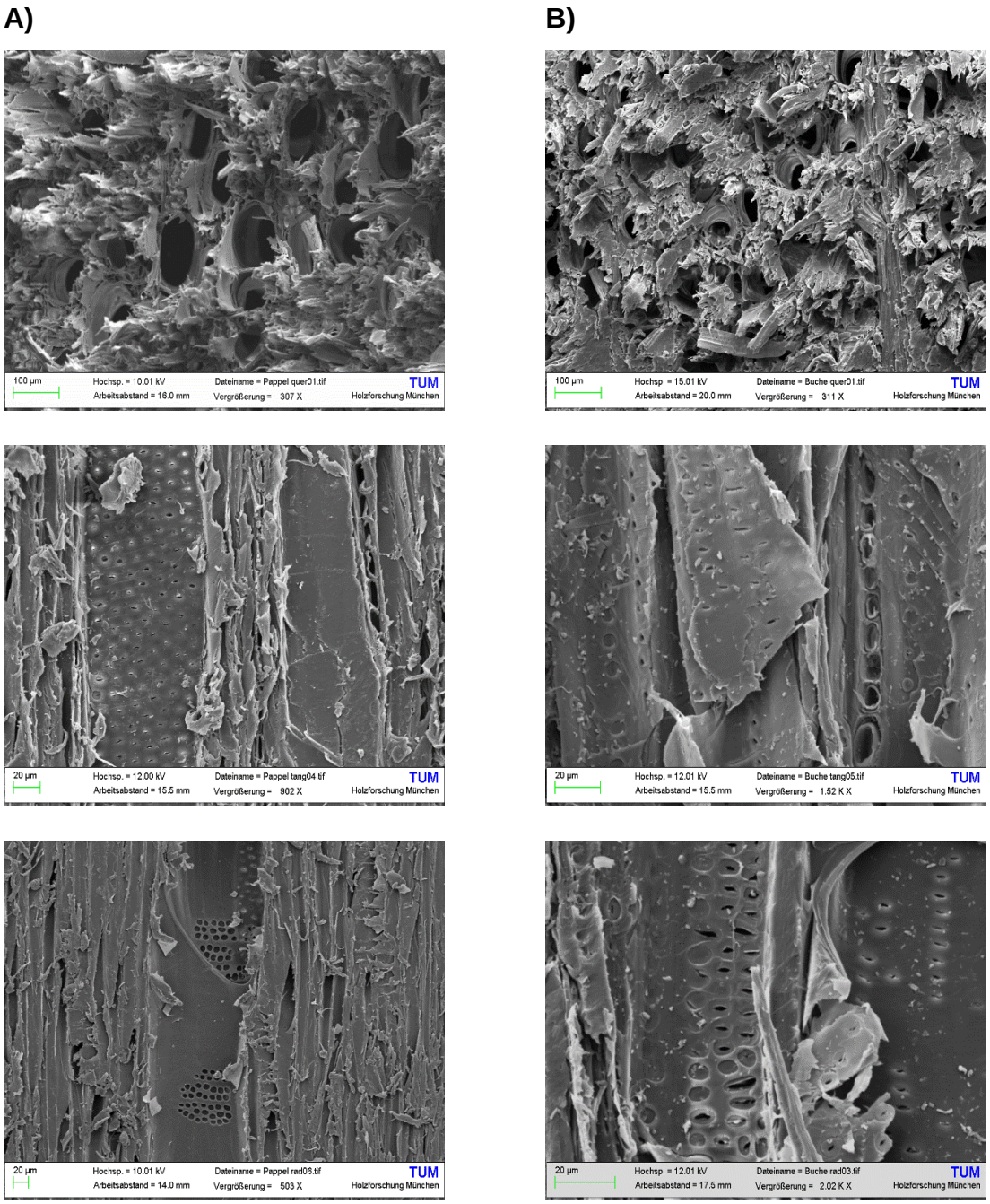


Figure SI-7. Scanning electron microscope image of the two angiosperm species – A) poplar and B) beech in the longitudinal (upper), radial (middle), and tangential (bottom) directions.

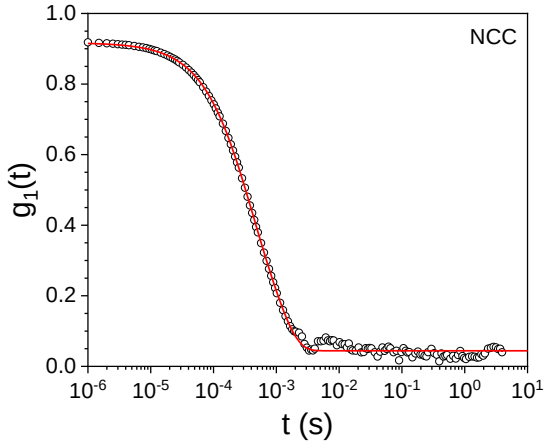
Table SI-1. Density ρ for the four wood species, mean diameter values d of tracheids (silver fir and Douglas fir) and vessels (poplar and beech) in the L-directions, and minor/major diameter values for rays and pits in the R- and T-direction.

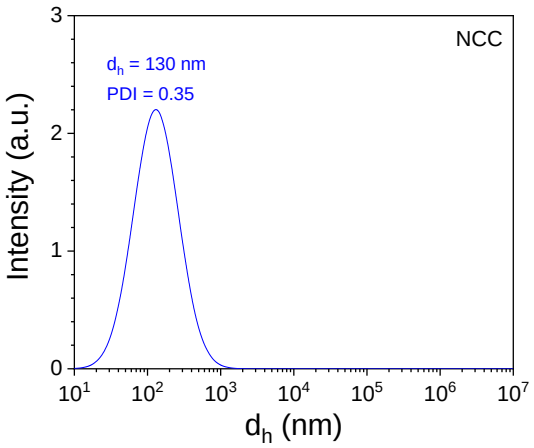
wood	ρ (kg/m^3)	d_L (μm)	d_R (μm)	d_T (μm)
silver fir	415	30-60	10-16	4-5
Douglas fir	530	30-60	8-18	7-8
poplar	400	80-150	9-19	7-8
beech	750	70-90	9-12	2-5

Table SI-2. Average flow rates during the filtration process for the four wood species in the three directions – water and 100 ppm nanoparticles.

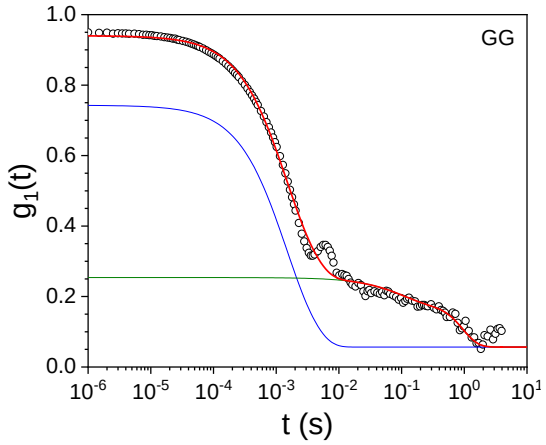
Q (mL/(h·cm^2))	silver fir	Douglas fir	poplar	beech
L	547	619	594	590
R	0.02	0.07	0.39	0.17
T	0.01	0.01	0.06	0.05

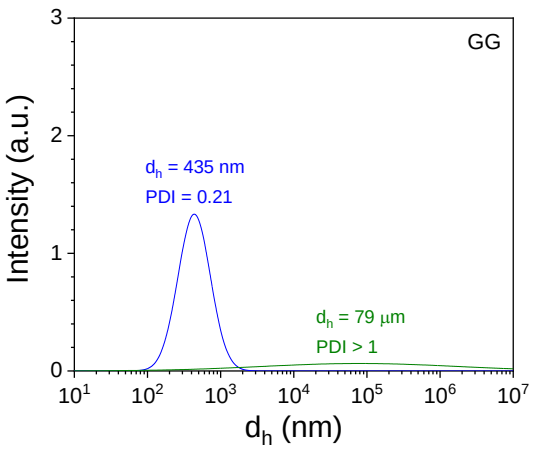
A)


NCC
g1(t)
t (s)

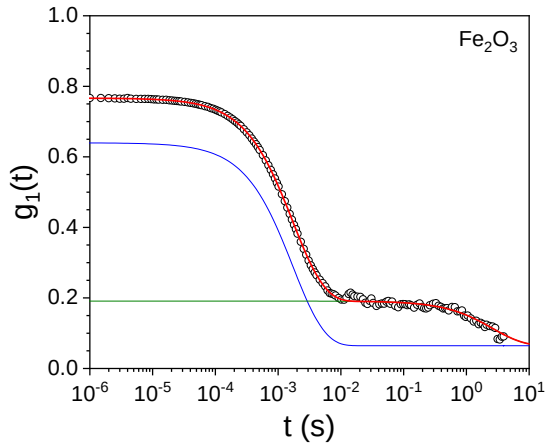

NCC
dh = 130 nm
PDI = 0.35
Intensity (a.u.)
dh (nm)

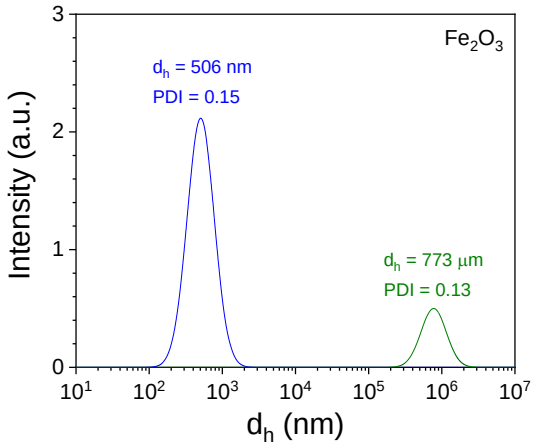
B)


GG
g1(t)
t (s)


GG
dh = 435 nm
PDI = 0.21
dh = 79 µm
PDI > 1
Intensity (a.u.)
dh (nm)

C)


Fe2O3
g1(t)
t (s)


Fe2O3
dh = 506 nm
PDI = 0.15
dh = 773 µm
PDI = 0.13
Intensity (a.u.)
dh (nm)

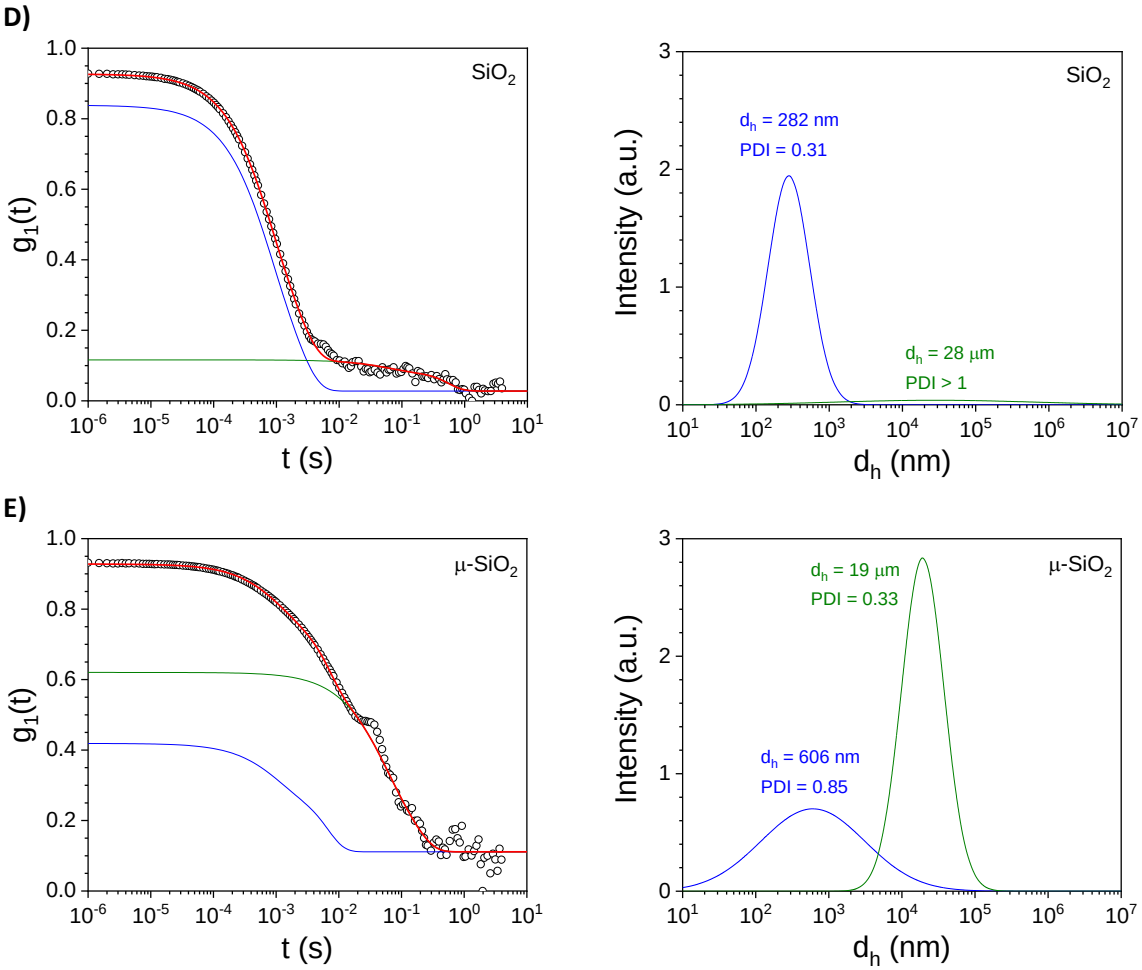


Figure SI-8. Left: DLS data (open symbols) and autocorrelation function $g_1(t)$ (red curve) of a *ca.* 100 ppm dispersion of A) NCC, B) GG, C) Fe_2O_3, D) SiO_2, and E) μ-SiO_2 tracers. Right: Intensity particle size distribution (PSD) obtained from the deconvolution of the DLS fitting function. *Note:* the blue and green curves are the deconvolution curves when more than one particle distribution was present in the sample.

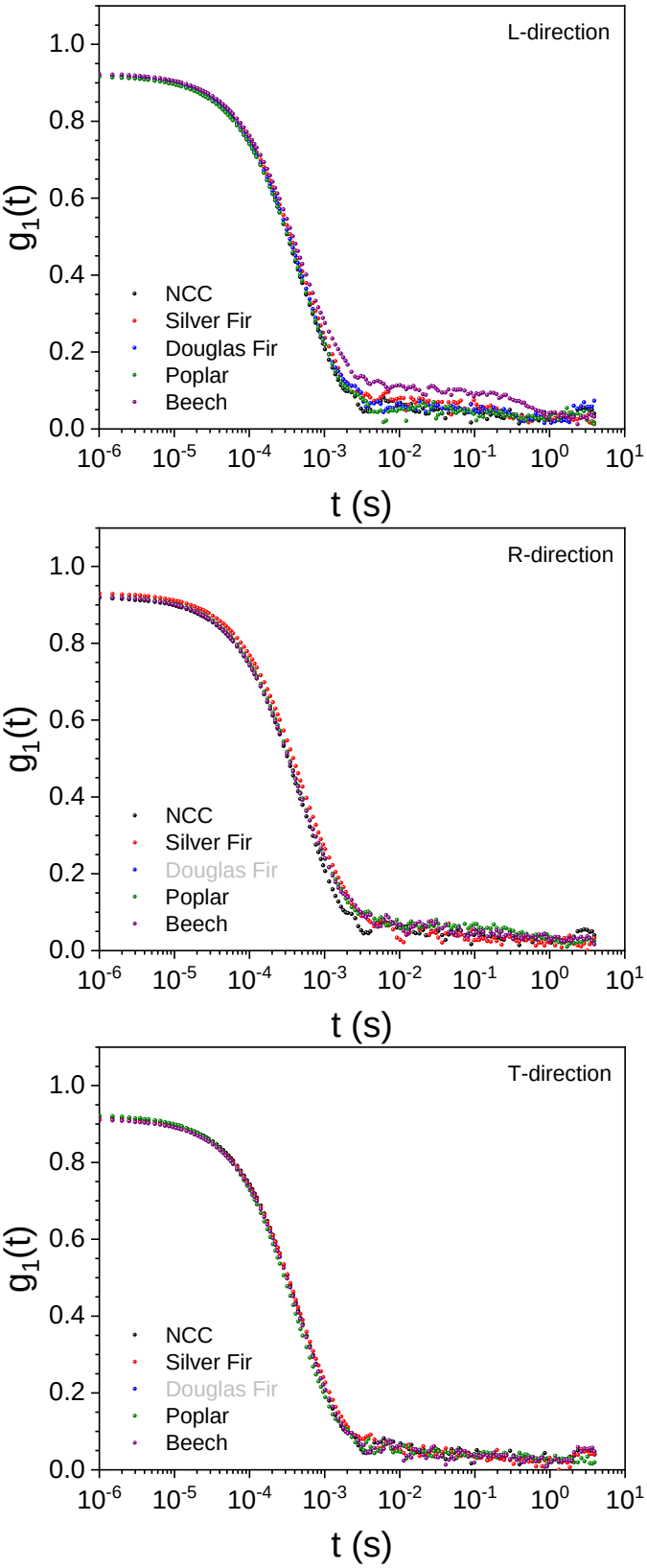


Figure SI-9. DLS data for the 130 ppm NCC dispersion (black), and after filtration for the four different wood species in the three orthotropic directions.

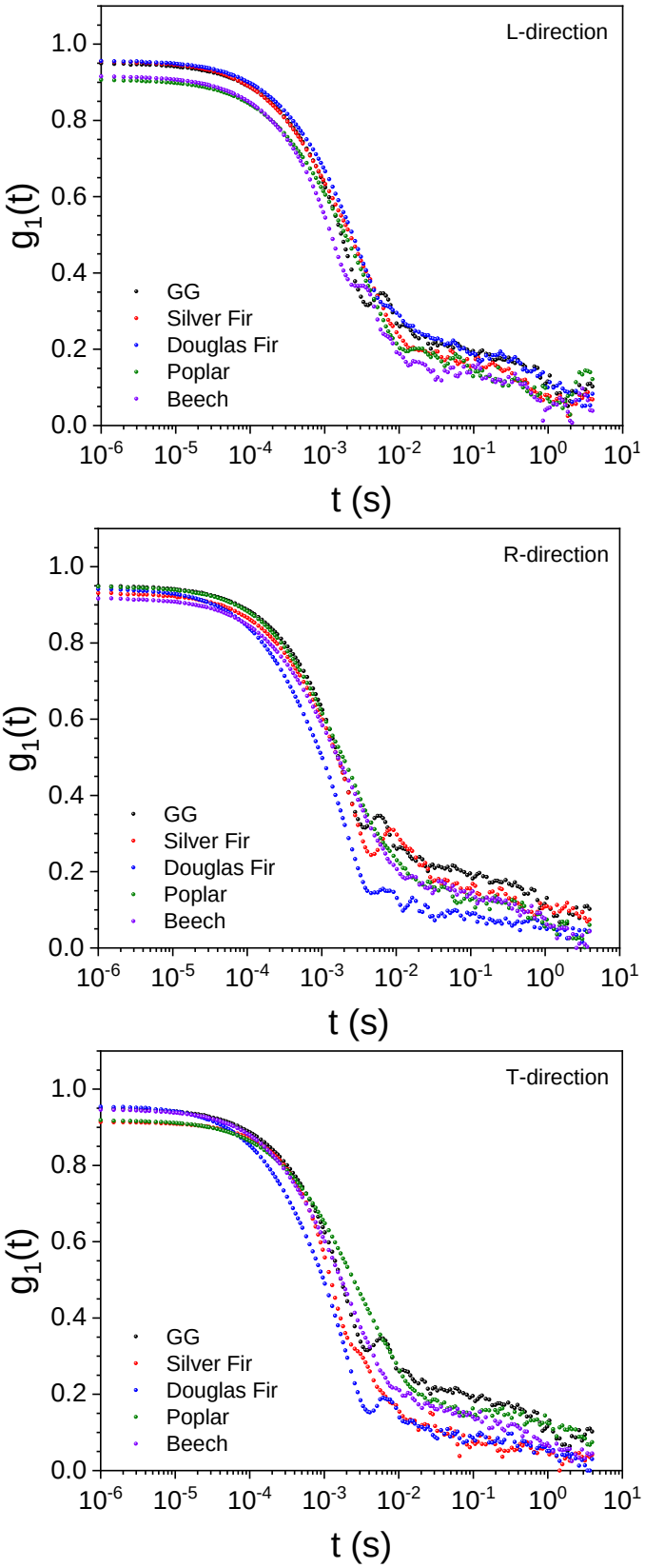


Figure SI-10. DLS data for the 104 ppm GG dispersion (black), and after filtration for the four different wood species in the three orthotropic directions.

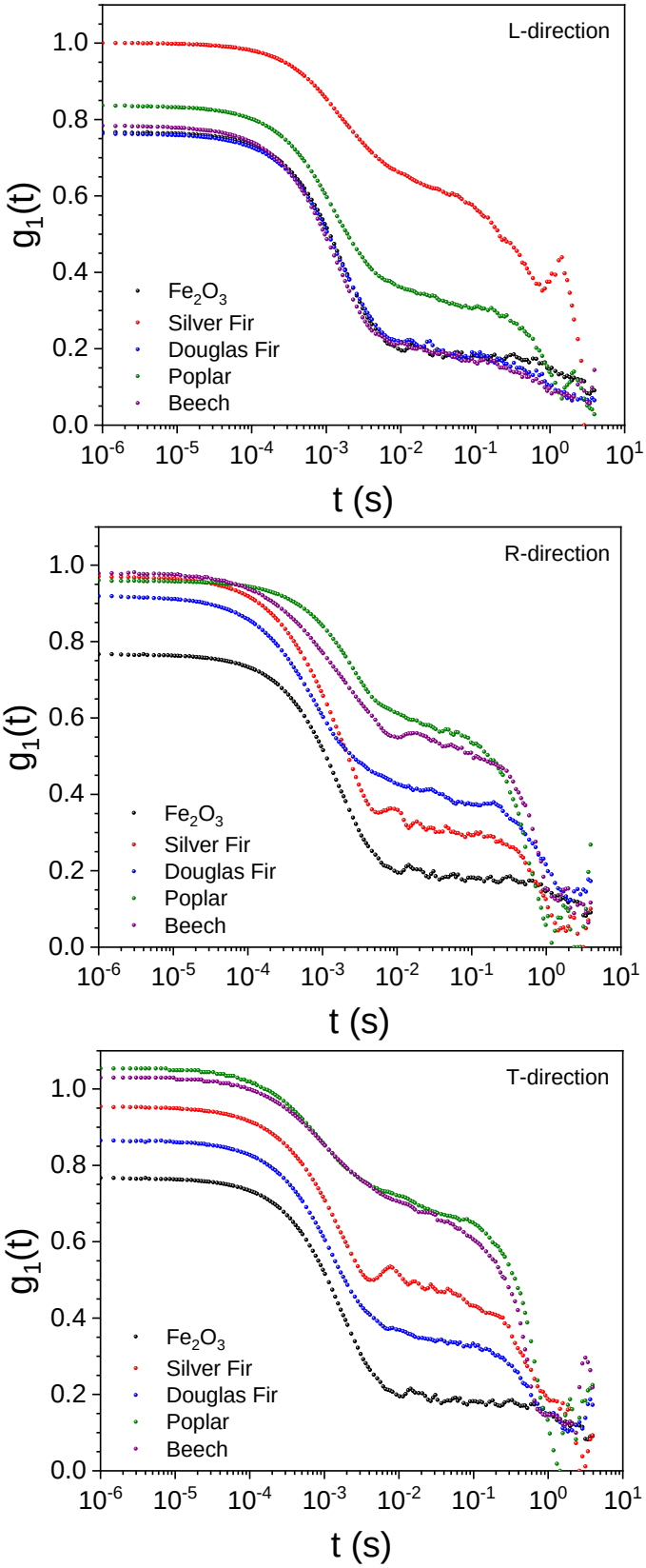


Figure SI-11. DLS data for the 105 ppm Fe_2O_3 dispersion (black), and after filtration for the four different wood species in the three orthotropic directions.

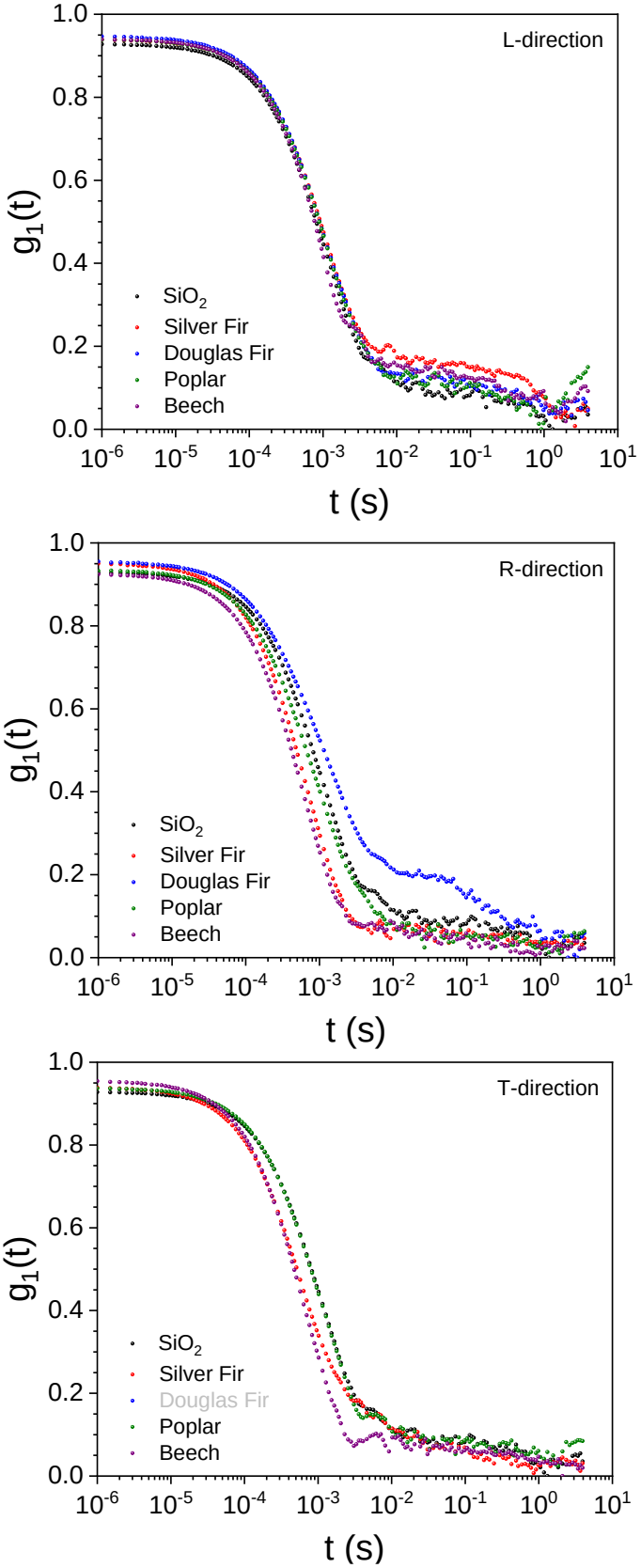


Figure SI-12. DLS data for the 100 ppm SiO_2 dispersion (black), and after filtration for the four different wood species in the three orthotropic directions.

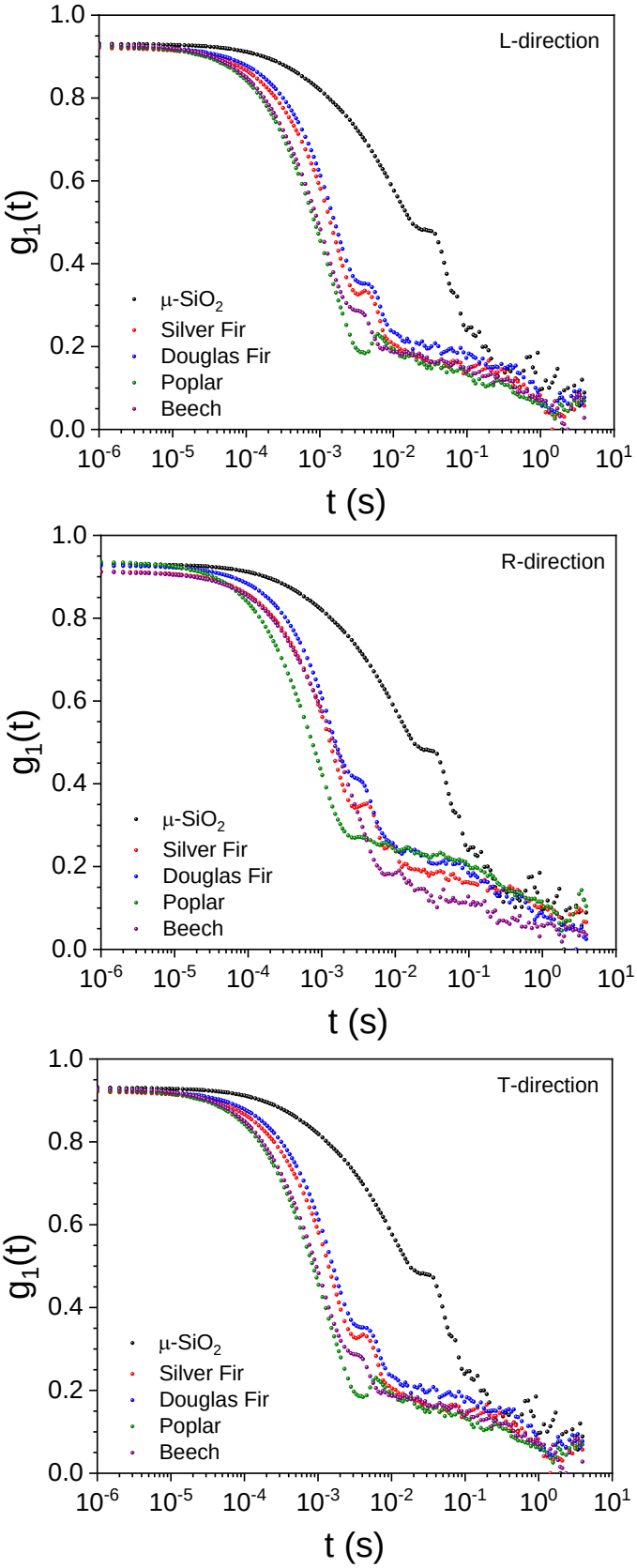


Figure SI-13. DLS data for the 115 ppm μ-SiO_2 dispersion (black), and after filtration for the four different wood species in the three orthotropic directions.

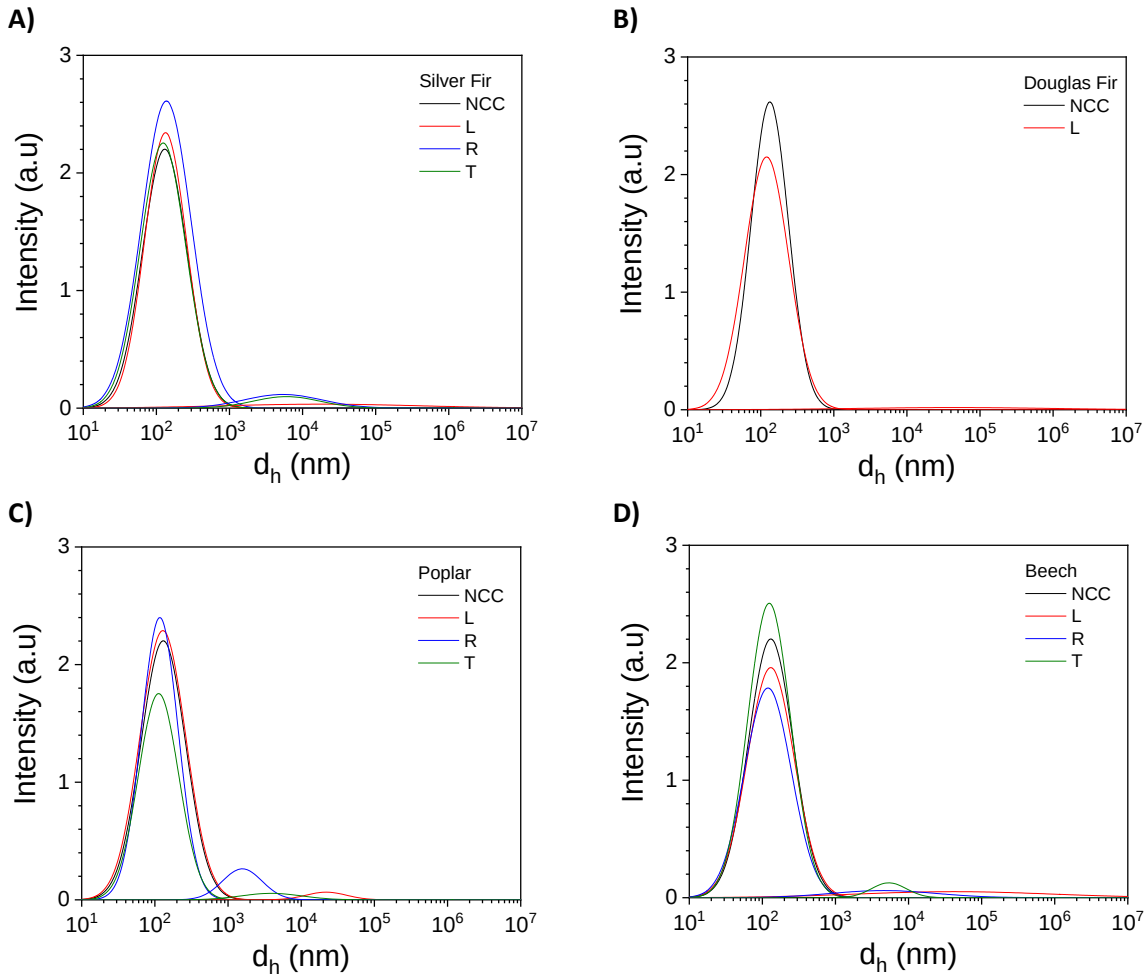


Figure SI-14. Intensity particle size distribution (PSD) of the NCC filtrates in the three directions (L, red; R, blue; T, green) for the four different wood species: A) silver fir, B) Douglas fir, C) poplar, and D) beech. The black curves correspond to the *ca.* 100 ppm dispersion before filtering.

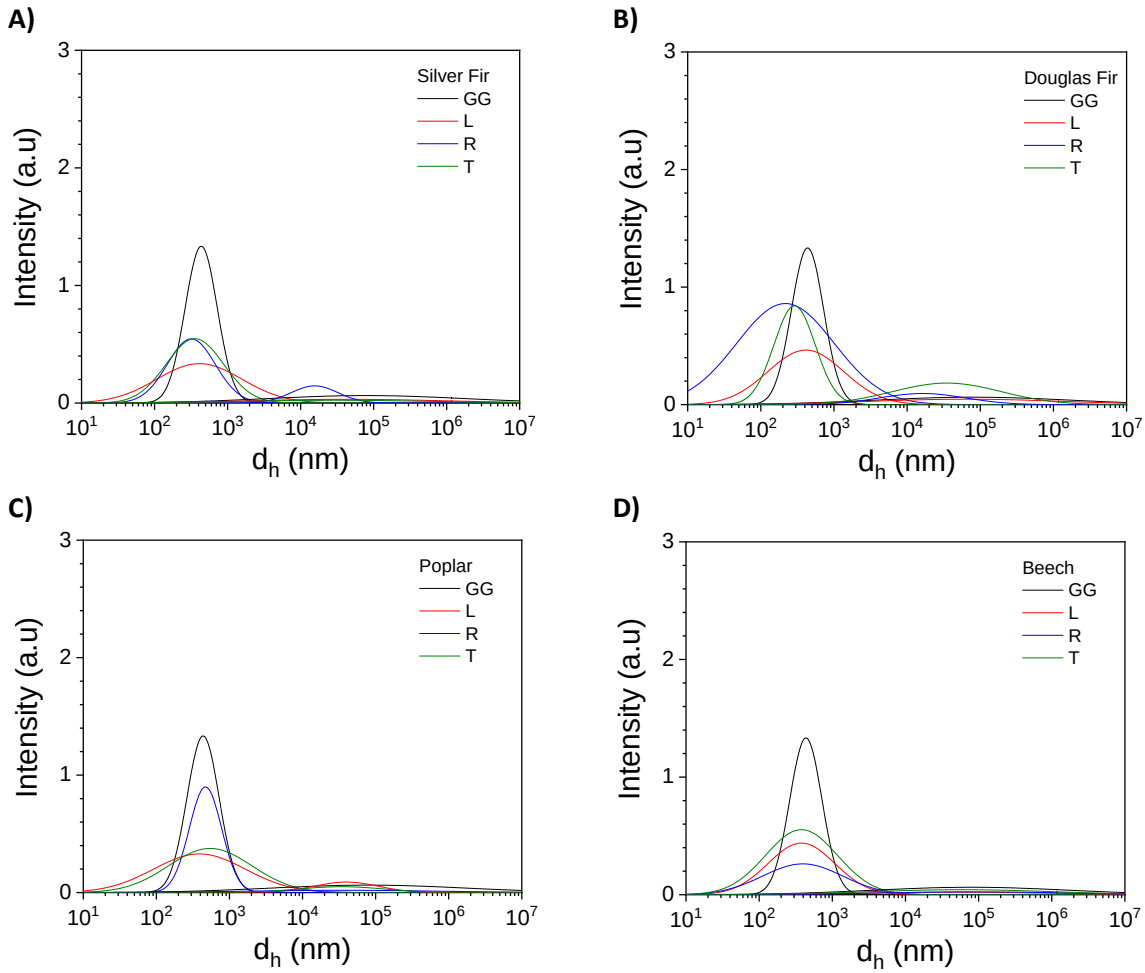


Figure SI-15. Intensity particle size distribution (PSD) of the GG filtrates in the three directions (L, red; R, blue; T, green) for the four different wood species: A) silver fir, B) Douglas fir, C) poplar, and D) beech. The black curves correspond to the *ca.* 100 ppm dispersion before filtering.

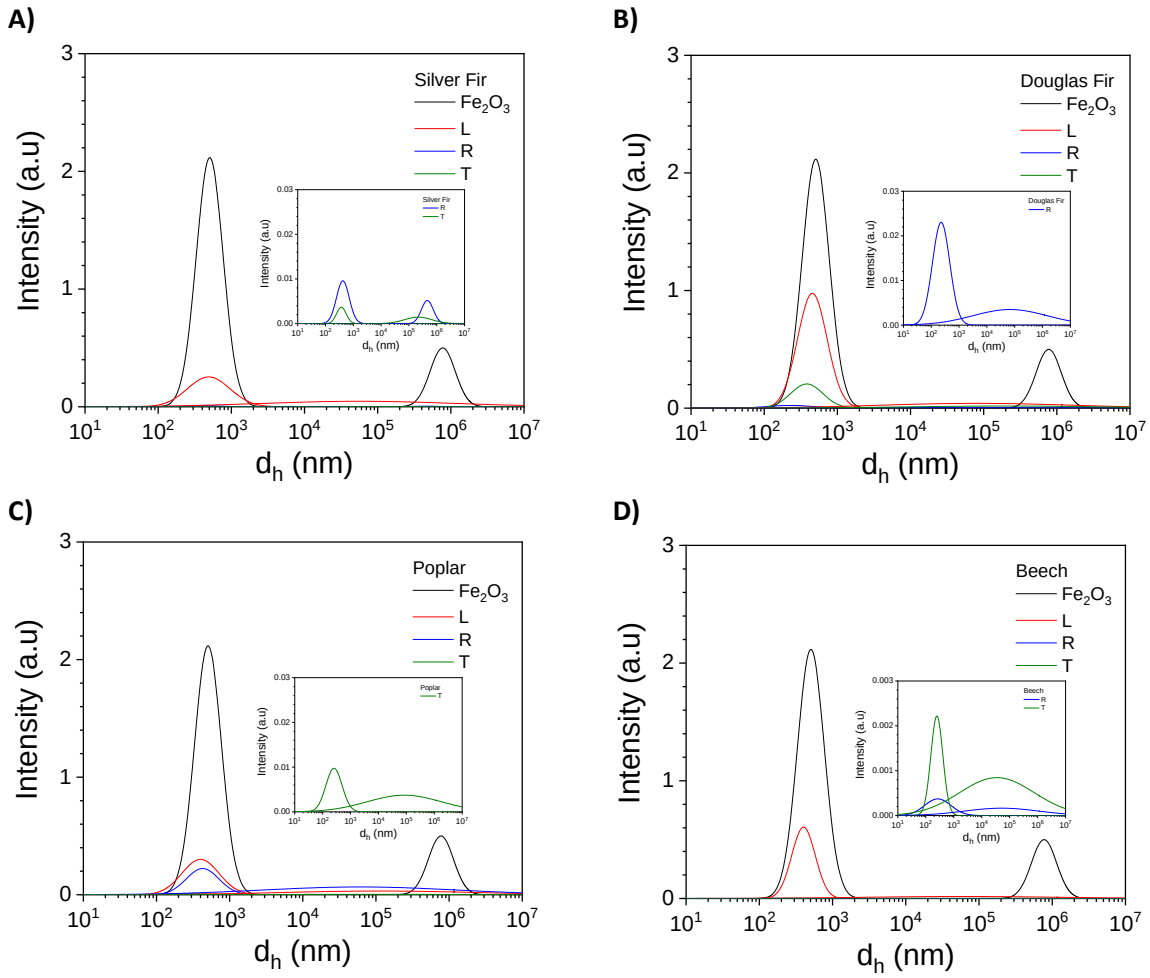


Figure SI-16. Intensity particle size distribution (PSD) of the Fe_2O_3 filtrates in the three directions (L, red; R, blue; T, green) for the four different wood species: A) silver fir, B) Douglas fir, C) poplar, and D) beech. The black curves correspond to the *ca.* 100 ppm dispersion before filtering.

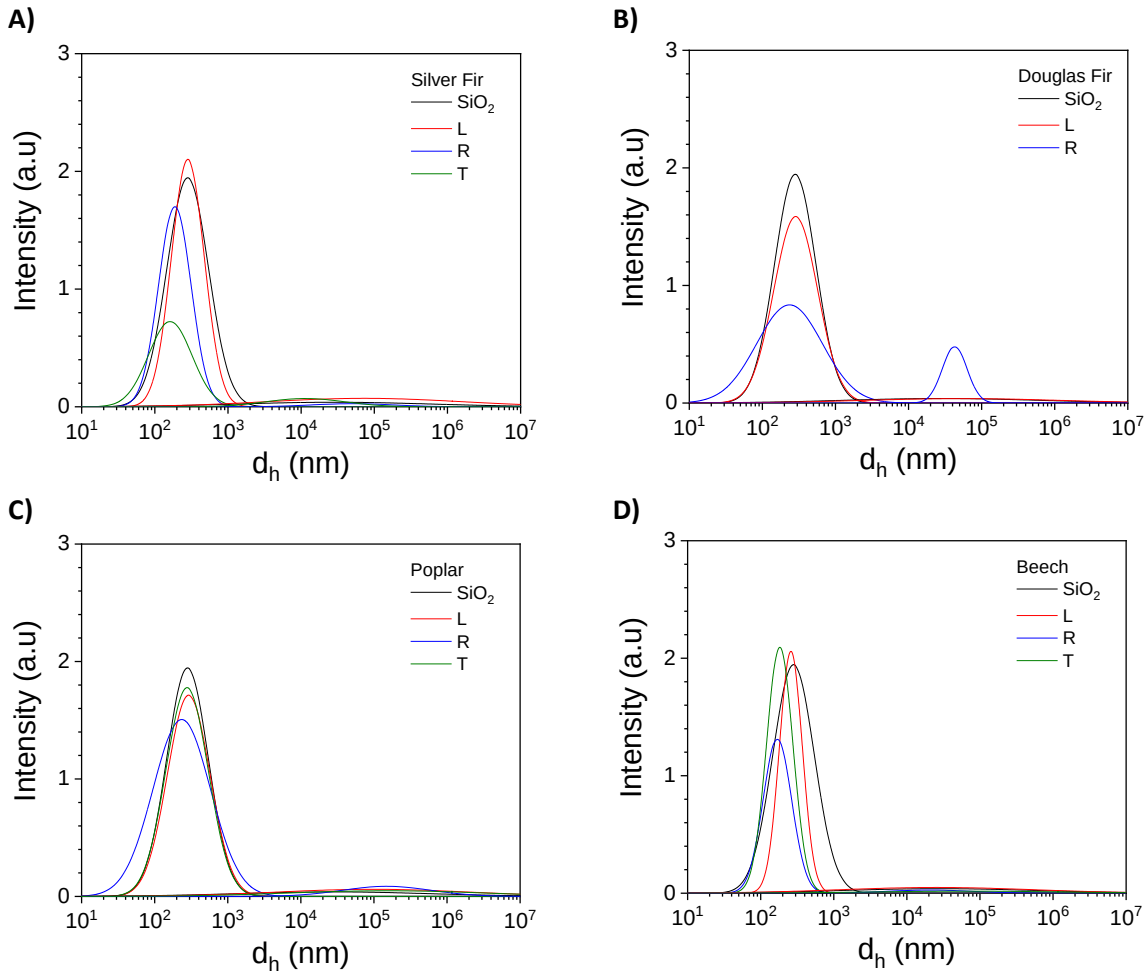


Figure SI-17. Intensity particle size distribution (PSD) of the SiO_2 filtrates in the three directions ((L, red; R, blue; T, green) for the four different wood species: A) silver fir, B) Douglas fir, C) poplar, and D) beech. The black curves correspond to the *ca.* 100 ppm dispersion before filtering.

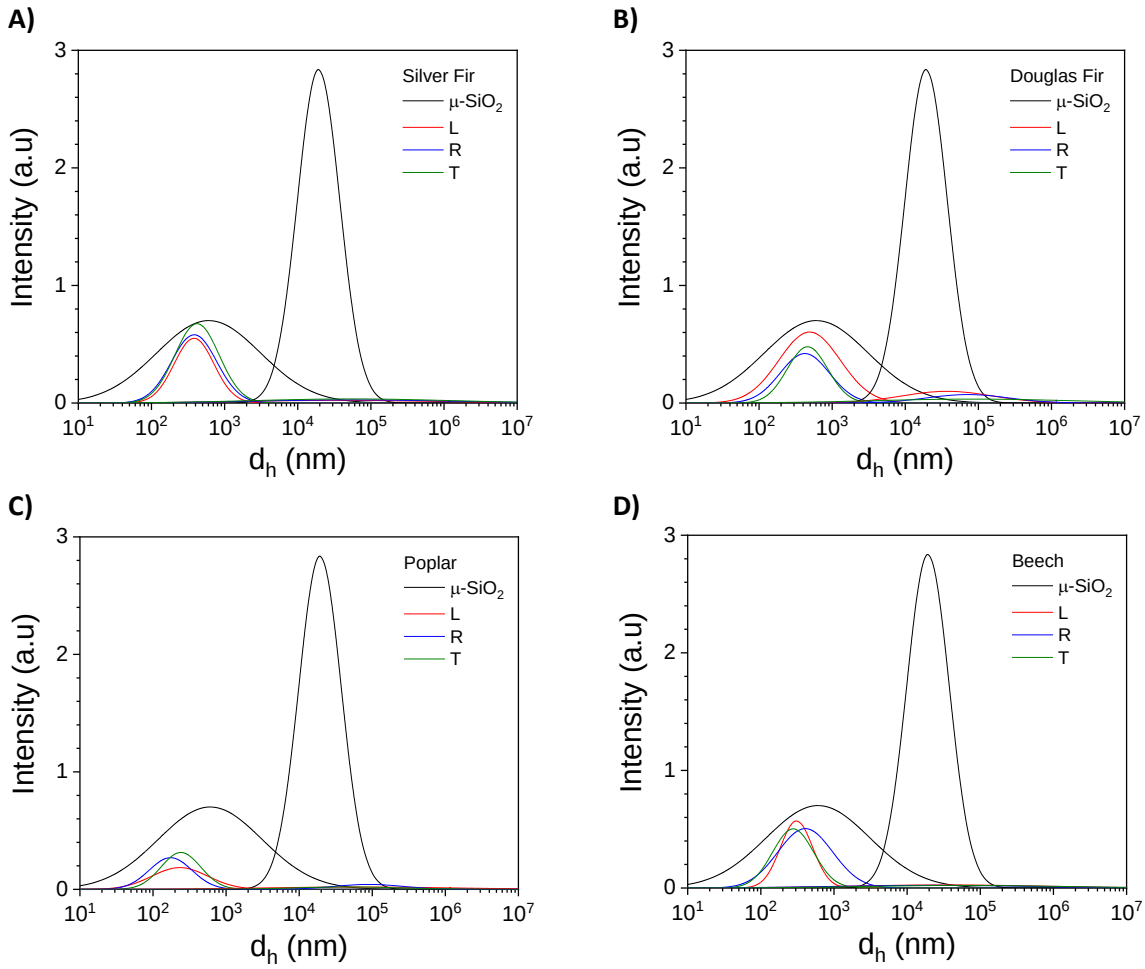


Figure SI-18. Intensity particle size distribution (PSD) of the μ-SiO_2 filtrates in the three directions (L, red; R, blue; T, green) for the four different wood species: A) silver fir, B) Douglas fir, C) poplar, and D) beech. The black curves correspond to the *ca.* 100 ppm dispersion before filtering.

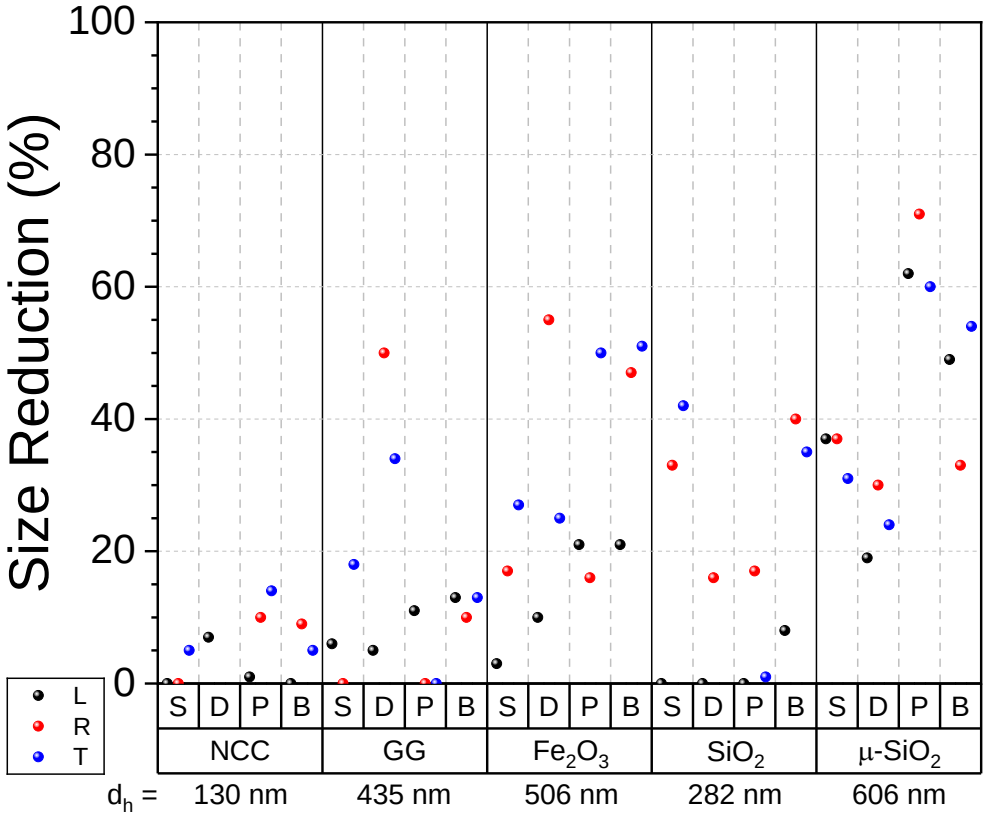


Figure SI-19. Size reduction percentage for the four wood species (S = silver fir, D = Douglas fir, P = poplar, B = beech) in the three directions (L, R and T) for the five tracers (NCC, GG, Fe_2O_3, SiO_2 and μ-SiO_2) after filtration. The orange dotted line corresponds to 100% efficiency.

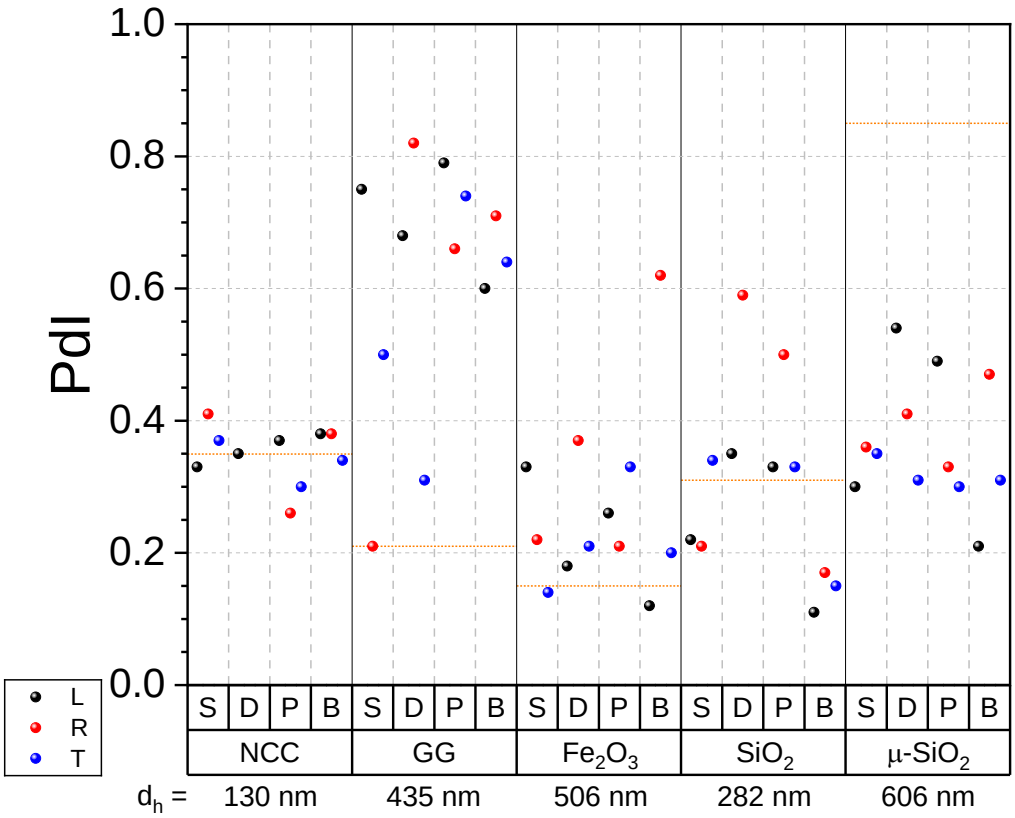


Figure SI-20. Polydispersity index of the filtrates for the four wood species (S = silver fir, D = Douglas fir, P = poplar, B = beech) in the three directions (L, R and T) with the five tracers (NCC, GG, Fe_2O_3, SiO_2 and μ-SiO_2) after filtration. The orange dotted line corresponds to 100% efficiency.

Table SI-3. Nanoparticles removal per mass of wood for each tracer and for the four wood species and the three directions (L, R and T). The concentration before filtration for NNC, GG, Fe_2O_3, SiO_2 and μ-SiO_2 was 130, 104, 105, 100 and 115 ppm, respectively.

wood m (g)	**direction**	**NPs removal (mg/g)**				
		NCC	**GG**	**Fe_2O_3**	**SiO_2**	**μ-SiO_2**
silver fir 0.471 g	L	0	0.8	1.6	0.1	2.1
	R	0	0.9	2.2	0.7	2.0
	T	0	0.8	2.2	1.2	2.0
Douglas fir 0.601 g	L	0	0.3	0.8	0.2	1.5
	R	nd	0	1.7	0.4	1.6
	T	nd	0	1.5	nd	1.7
poplar 0.454 g	L	0	0.8	1.7	0.1	2.3
	R	0	0.2	1.7	0	2.3
	T	0.7	0.8	2.3	0.1	2.3
beech 0.851 g	L	0	0.5	0.9	0.1	1.2
	R	0.1	0.7	1.2	0.6	1.1
	T	0	0.2	1.2	0.4	1.2

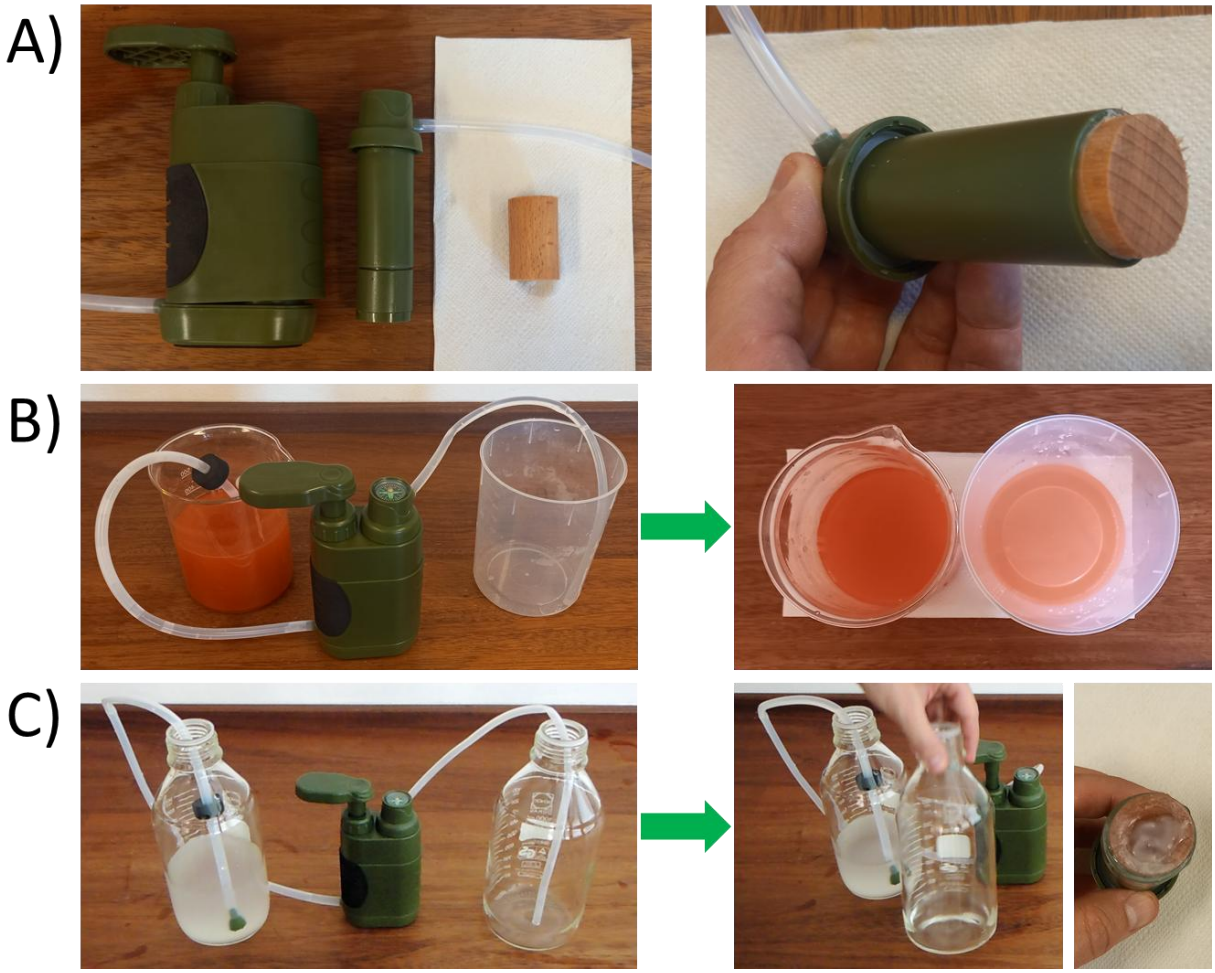
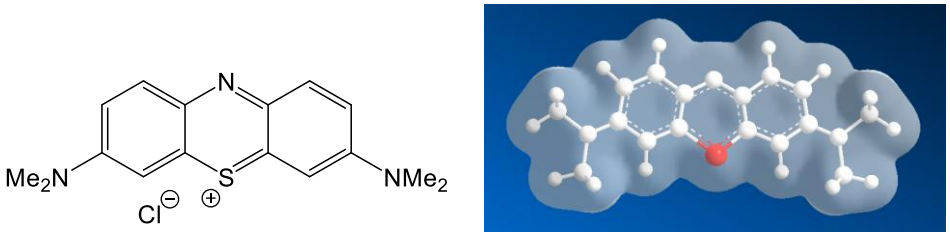


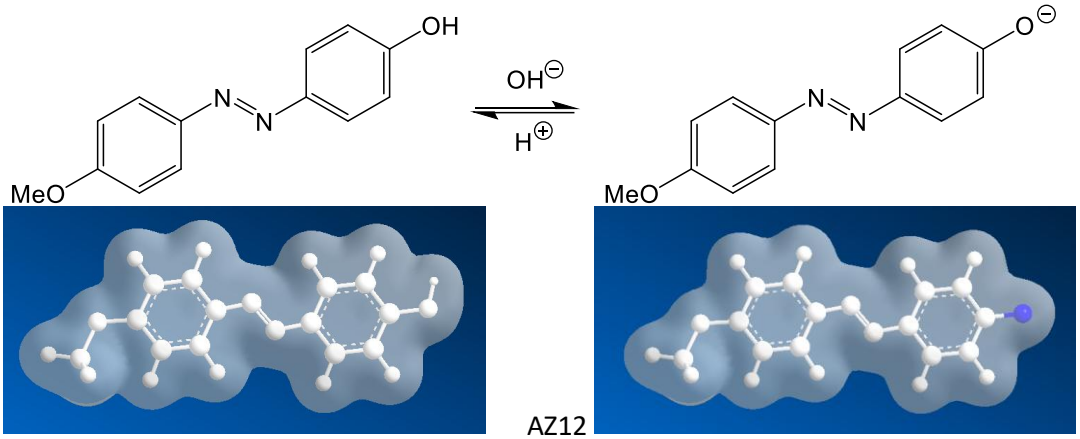
Figure SI-21. Details of a manual water filtration system using a cylinder of 4.5 mm in length and 2.5 mm in diameter beech wood sample in the L-direction. A) Filtration system and beech wood filter. B) Filtration of 100 ppm Fe_2O_3 NPs. C) Filtration of 1000 ppm μ-SiO_2 particles.

A)



mw = 319 Da, V = 0.269 nm^3, V_{exc} = 0.856 nm^3, μ = 4.3 D, R_g = 0.40 nm, d_{max} = 1.4 nm

B)

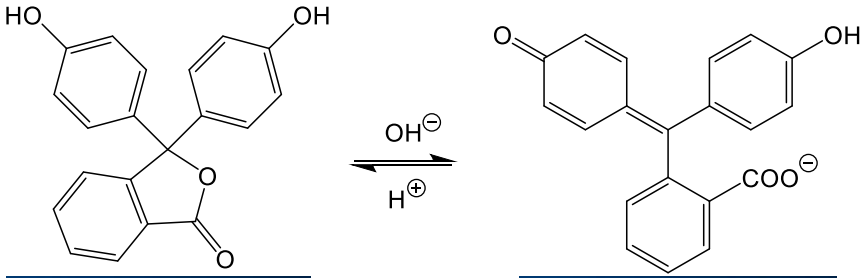


AZ4 AZ12

(AZ4) mw = 228 Da, V = 0.213 nm^3, V_{exc} = 0.725 nm^3, μ = 1.6 D, R_g = 0.39 nm, d_{max} = 1.4 nm

(AZ12) mw = 227 Da, V = 0.210 nm^3, V_{exc} = 0.715 nm^3, μ = 14.1 D, R_g = 0.39 nm, d_{max} = 1.4 nm

C)



PH4 PH12

(PH4) mw = 318 Da, V = 0.282 nm^3, V_{exc} = 0.880 nm^3, μ = 2.6 D, R_g = 0.35 nm, d_{max} = 1.0 nm

(PH12) mw = 317 Da, V = 0.283 nm^3, V_{exc} = 0.886 nm^3, μ = 25.5 D, R_g = 0.35 nm, d_{max} = 1.0 nm

Figure SI-22. Molecular structure, charge density (blue: negative; red: positive), molar mass, molecular volume, excluded volume, dipole moment, radius of gyration and the largest molecular distance for the three dye molecules: A) methylene blue (MB), B) azobenzene (AZ), and C) phenolphthalein (PH).

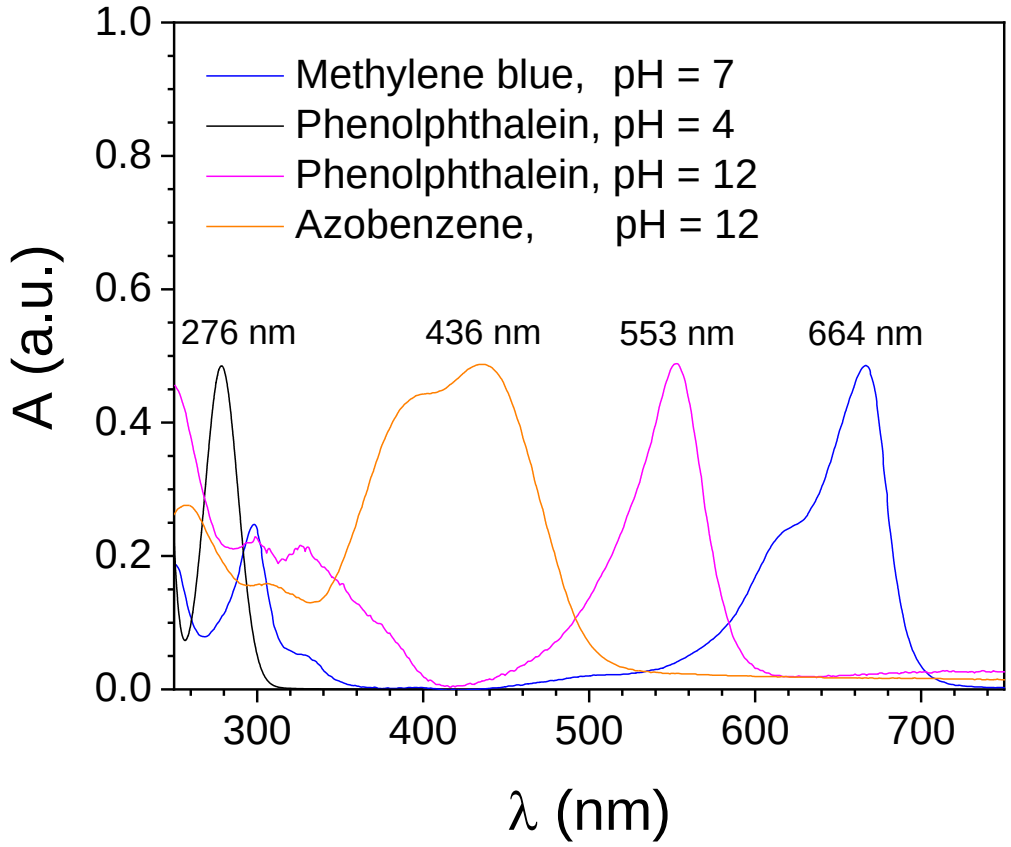


Figure 23. UV-vis spectra of methylene blue (pH 7) – blue -, phenolphthalein (pH 4) – black -, phenolphthalein (pH 12) – violet -, and azobenzene (pH 12) – orange – with the corresponding peak maxima.