

Supplementary Material

Effects of hydrophobicity-based fractions of Pony Lake fulvic acid on the colloidal stability and dissolution of oppositely charged surface-coated silver nanoparticles

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Table S1. Elemental composition and carbon distribution of PLFA sample (IHSS 2019a, IHSS 2019b).

Elemental composition (w/w %) ^A					Carbon distribution (%) ^B					
C	H	O	N	S	Carbonyl (190-220 ppm)	Carboxyl (165-190 ppm)	Aromatic (110-165 ppm)	Acetal (90-110 ppm)	Hetero- aliphatic (60-90 ppm)	Aliphatic (0-60 ppm)
52.5	5.4	31.4	6.5	3.0	1.2	17	12	0.2	8.4	61

All data were obtained from IHSS. ^A The values of the elemental composition are shown as the percent content of a dry, ash-free sample. ^B The carbon distribution shows the percentage of integrated peak area calculated from ¹³C NMR spectra. The ¹³C NMR chemical shifts for functional groups are given in parenthesis.

Table S2. Operating parameters for ICP-MS analysis.

Parameters	Setting
Forward power (W)	1550
Nebulizer gas flow (L min ⁻¹)	1.1
Sweeps	10
Replicates	5
Dwell time (ms)	30

Table S3. Mean hydrodynamic diameters (D_h , nm) as well as mean Pdl^A values of Cit-AgNPs and BPEI-AgNPs incubated in 10 mM NaNO₃ solution in the presence of HPO and TPI fractions of PLFA^B. The initial concentration of AgNPs was 2 mg L⁻¹. Mean values and standard deviations were calculated for 3 replicates.

Day	DLS ^C	2 mg L ⁻¹ Cit-AgNPs		2 mg L ⁻¹ BPEI-AgNPs	
		HPO PLFA	TPI PLFA	HPO PLFA	TPI PLFA
0	D_h	27.3 ± 0.2	28.9 ± 0.4	845.6 ± 115.5	1211.3 ± 113.4
	(Pdl)	(0.20 ± 0.01)	(0.20 ± 0.01)	(0.33 ± 0.06)	(0.40 ± 0.01)
1	D_h	27.4 ± 0.3	40.4 ± 12.9	761.9 ± 178.7	1249.9 ± 591.4
	(Pdl)	(0.20 ± 0.01)	(0.33 ± 0.06)	(0.67 ± 0.06)	(0.60 ± 0.01)
2	D_h	28.7 ± 0.8	41.8 ± 12.1	659.8 ± 54.5	1986.0 ± 310.4
	(Pdl)	(0.20 ± 0.01)	(0.35 ± 0.07)	(0.63 ± 0.06)	(0.80 ± 0.01)
3	D_h	28.7 ± 1.8	31.7 ± 1.2	794.9 ± 384.9	1226.6 ± 369.6
	(Pdl)	(0.15 ± 0.07)	(0.27 ± 0.06)	(0.63 ± 0.15)	(0.95 ± 0.03)
4	D_h	28.2 ± 0.5	53.1 ± 5.3	736.0 ± 137.5	1626.0 ± 264.4
	(Pdl)	(0.13 ± 0.06)	(0.47 ± 0.06)	(0.70 ± 0.10)	(0.84 ± 0.04)
5	D_h	28.3 ± 1.0	42.0 ± 3.8	641.2 ± 50.4	1933.0 ± 256.1
	(Pdl)	(0.17 ± 0.06)	(0.37 ± 0.06)	(0.57 ± 0.06)	(0.89 ± 0.03)
6	D_h	29.1 ± 0.6	45.5 ± 17.8	764.7 ± 246.2	1135.0 ± 137.0
	(Pdl)	(0.17 ± 0.06)	(0.20 ± 0.01)	(0.57 ± 0.21)	(0.96 ± 0.02)
7	D_h	28.8 ± 0.6	121.0 ± 85.5	663.1 ± 136.5	987.0 ± 141.6
	(Pdl)	(0.13 ± 0.06)	(0.40 ± 0.14)	(0.57 ± 0.06)	(0.84 ± 0.15)

^A Polydispersity index

^B Hydrophobic (HPO) and transphilic (TPI) fractions of PLFA

^C Dynamic light scattering

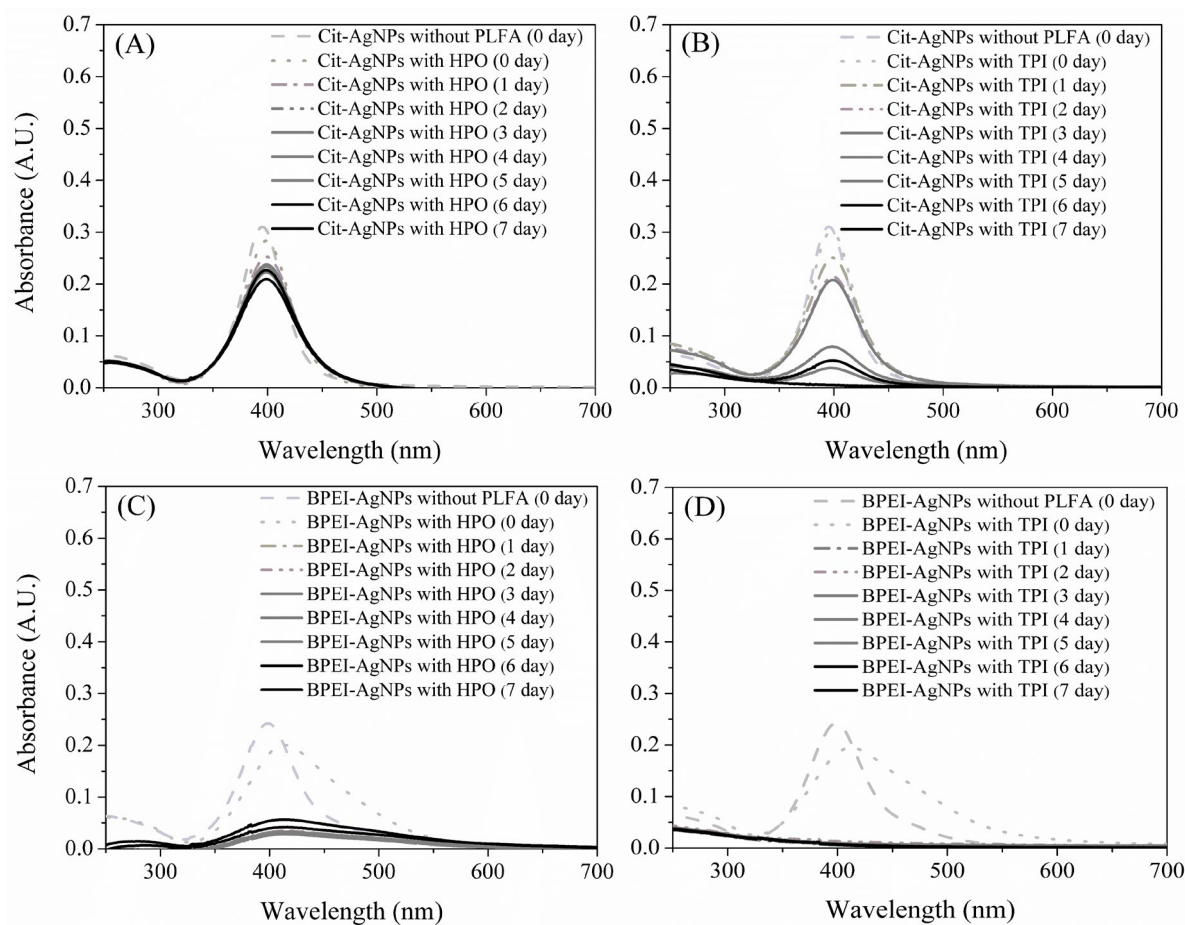


Figure S1. UV-vis absorption spectra of Cit-AgNPs (A and B) and BPEI-AgNPs (C and D) incubated in 10 mM NaNO₃ solution in the presence of the HPO and TPI fractions of PLFA for 7 days. The initial concentration of AgNPs was 2 mg L⁻¹.

Table S4. Mean zeta potential values and standard deviations (mV) of Cit-AgNPs and BPEI-AgNPs dispersed in 10 mM NaNO₃ solution in the presence of HPO and TPI fractions of PLFA. Mean values and standard deviations were calculated for 3 replicates.

Day	2 mg L ⁻¹ Cit-AgNPs		2 mg L ⁻¹ BPEI-AgNPs	
	HPO PLFA	TPI PLFA	HPO PLFA	TPI PLFA
0	-31.2 ± 1.6	-28.8 ± 2.2	-22.9 ± 1.5	-18.7 ± 1.5
1	-25.5 ± 1.4	-31.6 ± 0.8	-31.1 ± 1.1	-17.6 ± 7.4
2	-32.6 ± 1.2	-30.9 ± 0.5	-32.9 ± 1.6	-14.9 ± 3.0
3	-32.4 ± 0.4	-30.5 ± 1.1	-32.8 ± 3.6	-10.4 ± 9.5
4	-28.0 ± 0.8	-26.7 ± 3.3	-36.2 ± 1.4	-21.0 ± 1.8
5	-34.2 ± 2.5	-28.0 ± 2.3	-38.2 ± 1.9	-32.6 ± 5.2
6	-31.3 ± 1.6	-28.4 ± 2.5	-36.0 ± 2.1	-27.6 ± 9.3
7	-33.4 ± 1.2	-22.6 ± 2.5	-38.1 ± 1.9	-31.8 ± 9.8

Table S5. Mean pH values and standard deviations measured in 2 mg L⁻¹ BPEI-AgNPs dispersions in the presence of HPO and TPI fractions of PLFA. Mean concentrations and standard deviations were calculated for 3 replicates.

Day	2 mg L ⁻¹ BPEI-AgNPs	
	HPO PLFA	TPI PLFA
0	6.07 ± 0.01	6.17 ± 0.02
1	7.59 ± 0.01	7.24 ± 0.01
2	6.87 ± 0.01	6.92 ± 0.01
3	6.97 ± 0.01	6.96 ± 0.01
4	6.75 ± 0.01	6.78 ± 0.01
5	6.75 ± 0.01	6.76 ± 0.01
6	6.85 ± 0.01	6.89 ± 0.01
7	6.67 ± 0.02	6.77 ± 0.01

Table S6. Mean concentrations and standard deviations ($\mu\text{g L}^{-1}$) of dissolved Ag released from Cit-AgNPs and BPEI-AgNPs dispersed in 10 mM NaNO_3 solution in the presence of HPO and TPI fractions of PLFA. AgNPs were separated from dissolved fraction using the ultrafiltration membrane with the MWCO of 50 kDa. Mean concentrations and standard deviations were calculated for 3 replicates.

Day	2 mg L ⁻¹ Cit-AgNPs		2 mg L ⁻¹ BPEI-AgNPs	
	HPO PLFA	TPI PLFA	HPO PLFA	TPI PLFA
0	2.3 ± 0.1	2.1 ± 0.6	12.2 ± 0.2	10.3 ± 1.1
1	6.6 ± 0.6	7.0 ± 1.8	4.9 ± 0.8	1.8 ± 0.5
2	3.1 ± 0.9	8.2 ± 3.1	3.4 ± 1.0	1.1 ± 0.3
3	8.7 ± 0.2	11.4 ± 0.5	3.4 ± 0.4	0.9 ± 0.4
4	11.4 ± 1.9	11.6 ± 0.6	2.3 ± 0.3	0.7 ± 0.1
5	11.3 ± 1.2	15.5 ± 2.1	3.2 ± 0.3	0.9 ± 0.1
6	14.3 ± 2.6	14.7 ± 0.8	2.9 ± 0.6	1.0 ± 0.0
7	13.8 ± 1.6	15.0 ± 1.5	3.7 ± 0.8	0.8 ± 0.1

REFERENCES

- IHSS: International Humic Substances Society (2019a). ¹³C NMR estimates of carbon distribution. Available at <http://humic-substances.org/13c-nmr-estimates-of-carbon-distribution-in-ihss-samples/> [verified 1 March 2019]
- IHSS: International Humic Substances Society (2019b). Elemental compositions and stable isotopic ratios of IHSS samples. Available at <http://humic-substances.org/elemental-compositions-and-stable-isotopic-ratios-of-ihss-samples/> [verified 1 March 2019]