

Supporting information for

Influence of extracellular polymeric substances from activated sludge on the aggregation

kinetics of silver and silver sulfide nanoparticles

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Text S1 Enzymatic Digestion of EPS

Protease and streptase were used to remove proteins in EPS. The enzymatic digestion process was as follows: First, 2 g/L stock solution of EPS was prepared before the experiment; then, 1 % (w/w) streptase was added to the EPS solution and incubated at 37 °C for 12 h; after that, 1 % (w/w) of protease was added and incubated at 60 °C for another 12 h.

Cellulase was used to remove polysaccharides in EPS. The enzymatic digestion process was similar to the above: First, 2 g/L stock solution of EPS was prepared before the experiment; and 2 % (w/w) cellulase was added to the EPS solution; the final mixed solution was incubated at 55 °C for 4 h.

Text S2 FTIR characterization

FTIR spectra were obtained on a spectrometer (IFS 66 v/s, Bruker, Karlsruhe, Germany) equipped with Mercury Cadmium Telluride (MCT)-(MIR) liquid nitrogen-cooled detector and OPUS 5.5 processing software. The pellet was prepared by pressing EPS and KBr (1:100) into a mold. And the FTIR spectrum was acquired in the 4000-400 cm^{-1} region with a resolution of 4 cm^{-1} .

Text S3 Adsorption experiments

The adsorption amount of different EPS on the surface of Cit-Ag NPs and Ag₂S NPs was appraised via a batch adsorption test. The two NPs stock suspensions were diluted 50 times and added to solutions contained 5 mg.L⁻¹ B-EPS, AT-EPS, and PT-EPS. The samples were shaken for 12 h at 300 rpm at 25°C and filtered through a 0.45µm membrane. The TOC of the mixed solutions was then measured by TOC/TN analyzer (multi N/C 3100, Analytik Jena, Germany).

Fig. S1 FTIR spectra of B-EPS

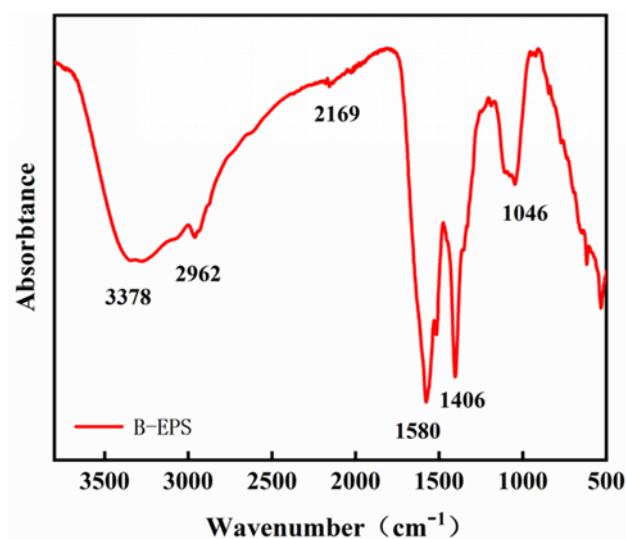


Fig. S1 FTIR spectra of B-EPS

Fig. S2 The variation of the particle sizes of EPS

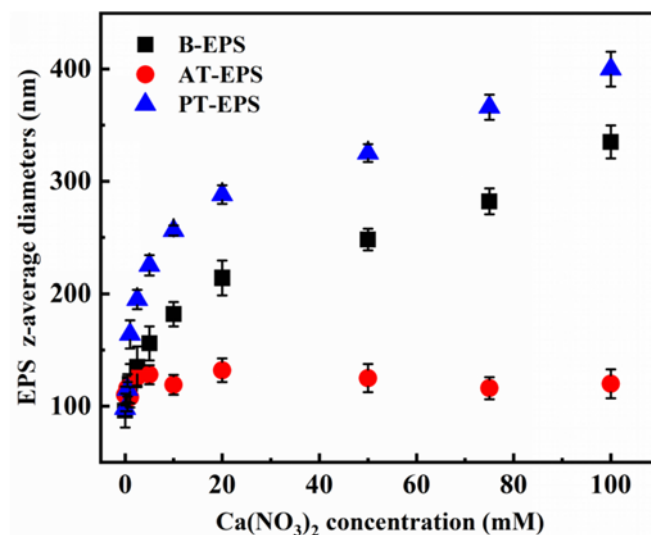


Fig. S2 Particle size of B-EPS, AT-EPS, and PT-EPS with the increasing concentration of Ca(NO₃)₂ solution (pH 6.0, 25 °C)

Table S1, S2 Characteristics of Cit-Ag NPs and Ag₂S NPs in the absence and presence of EPS at pH 6.0 and 25 °C

Table S1 Characteristics of Cit-Ag NPs in the absence and presence of EPS at pH 6.0 and 25 °C

EPS types	hydrodynamic diameter/nm	PDI	zeta potential/mV	EPM/10 ⁻⁸ m ² V ⁻¹ s ⁻¹
With no EPS	56.5±3.11	0.106	-36.23±3.51	2.84±0.6
With 1 mg/L B-EPS	63.3±1.26	0.185	-22.6±3.02	-1.74±0.19
With 1 mg/L PT-EPS	59.4±0.98	0.141	-24.1±1.52	-1.88±0.15
With 1 mg/L AT-EPS	65.2±1.15	0.157	-25.1±2.13	-1.96±0.26

Table S2 Characteristics of Ag₂S NPs in the absence and presence of EPS at pH 6.0 and 25 °C

EPS types	hydrodynamic diameter/nm	PDI	zeta potential/mV	EPM/10 ⁻⁸ m ² V ⁻¹ s ⁻¹
With no EPS	78.5±1.31	0.166	-32.23±3.67	2.51±0.4
With 1mg/L B-EPS	88.3±1.26	0.105	-19.34±2.36	-1.55±0.18
With 1 mg/L PT-EPS	94.4±0.98	0.125	-20.784±3.14	-1.39±0.23
With 1 mg/L AT-EPS	90.4±2.05	0.131	-16.58±3.47	-1.21±0.17

Table S3, S4 Adsorption of EPS on Cit-Ag NPs and Ag₂S NPs at pH 6.0 and 25°C**Table S3** Adsorption of EPS on Cit-Ag NPs at pH 6.0 and 25°C

EPS type	C ₀ (mg.L ⁻¹) ^a	C _e (mg.L ⁻¹) ^b	Q _e (mg.g ⁻¹) ^c	Q _i (mg.m ⁻²) ^f
B-EPS	5	0.97±0.14 ^d	2410±41.6	34.41±1.47
AT-EPS	5	1.18±0.16	2230±48.21	31.85±1.64
PT-EPS	5	1.36±0.11	2188±53.4	31.26±1.52

Table S4 Adsorption of EPS on Ag₂S NPs at pH 6.0 and 25°C

EPS type	C ₀ (mg.L ⁻¹) ^a	C _e (mg.L ⁻¹) ^b	Q _e (mg.g ⁻¹) ^c	Q _i (mg.m ⁻²) ^f
B-EPS	5	1.49±0.14 ^d	1210±24.5	50±2.1
AT-EPS	5	2.14±0.13	2.14±0.13	41.08±1.8
PT-EPS	5	2.00±0.11	1052±15.6	48.83±1.3

^a C₀ was the initial TOC concentration of organic matters, ^b C_e was the TOC concentration of EPS after centrifugation,

^c Q_e was the adsorption amount of EPS on of Cit-Ag NPs and Ag₂S NPs, ^d Mean±St deviation, ^f Q_i was the adsorption

amount for EPS on a specific surface area of the two NPs in each test medium (mg/m²). The reported specific surface

area of Cit-Ag NPs was 46~92 m²/g (Mo et al., 2019), and that of Ag₂S NPs was 24 m²/g (Saleh et al., 2010).

References

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