

Supplementary materials

Manuscript title: Effects of Four Kinds of Oxide Nanoparticles on Protein in EPS of Sludge

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Part S1 Characterization of NPs: SEM image and EDS spectrum of nanoparticles

(a) SEM image of Al₂O₃ nanoparticles (NPs)

(b) EDS spectrum of Al₂O₃ nanoparticles (NPs)

(c) SEM image of Fe₃O₄ NPs

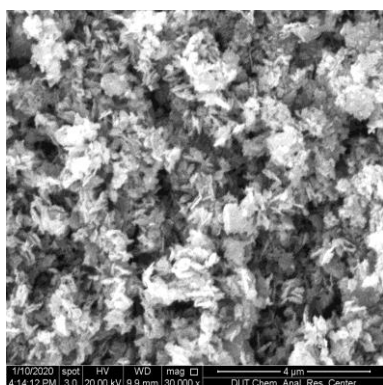
(d) EDS spectrum of Fe₃O₄ NPs

(e) SEM image of ZnO NPs

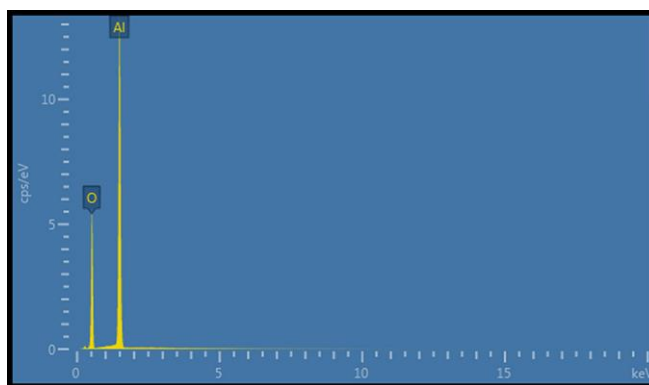
(f) EDS spectrum of ZnO NPs

(g) SEM image of TiO₂ NPs

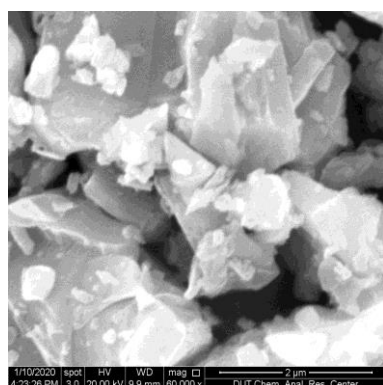
(h) EDS spectrum of TiO₂ NPs



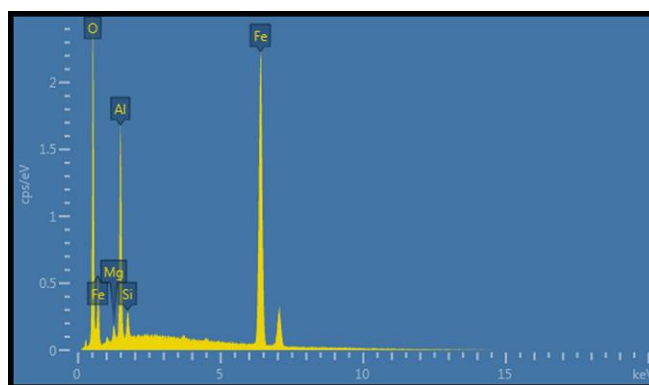
(a)



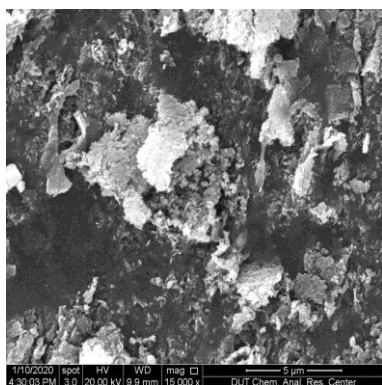
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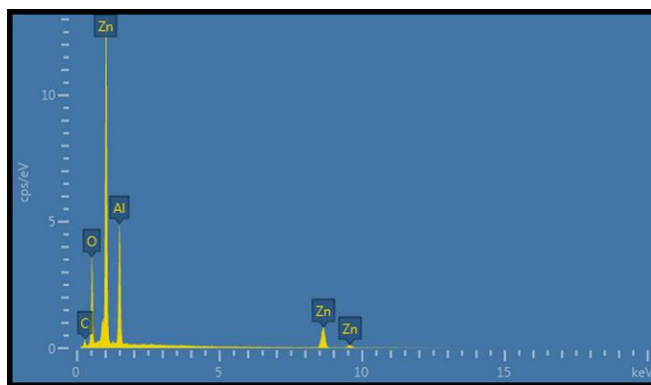
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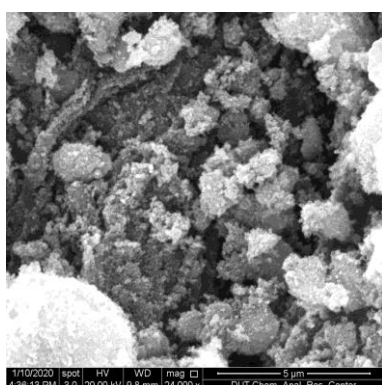
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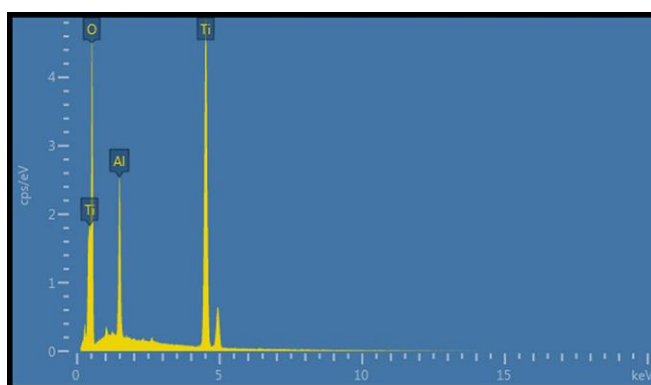
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(f)



(g)



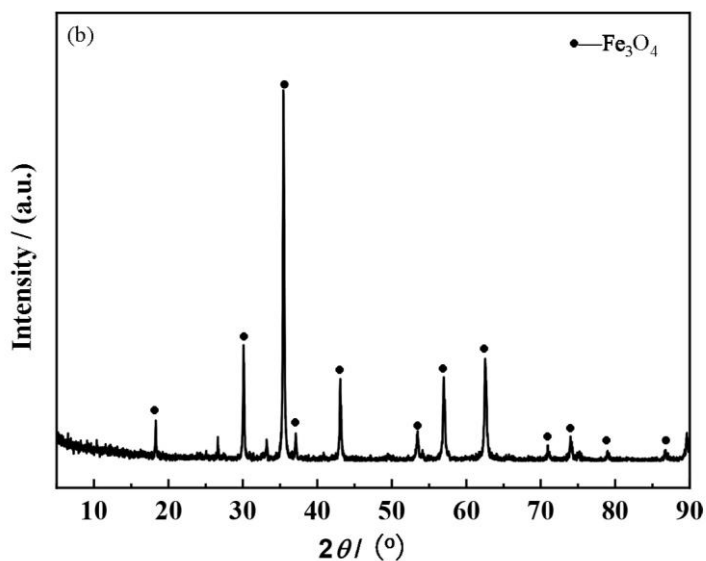
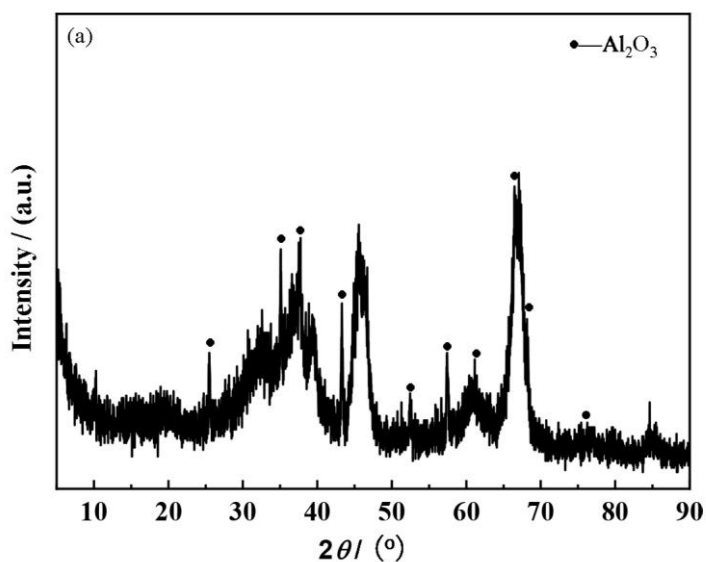
(h)

Fig. S1. The SEM image (a) and EDS spectrum (b) of Al_2O_3 nanoparticles (NPs), The SEM image (c) and EDS spectrum (d) of Fe_3O_4 NPs , The SEM image (e) and EDS spectrum (f) of ZnO NPs, The SEM image (g) and EDS spectrum (h) of TiO_2 NPs.

Part S2 Characterization of NPs: XRD patterns and average size of nanoparticles

XRD patterns was analyzed by jade 9.0 software, after calculation, the particle size of Fe_3O_4 NPs is larger given 30nm, and the sizes of other nanoparticles are almost 30nm.

- (a) XRD pattern of Al_2O_3 nanoparticles (NPs), the average size of Al_2O_3 NPs is 34nm.
- (b) XRD pattern of Fe_3O_4 NPs, the average size of Fe_3O_4 NPs is 92 nm.
- (c) XRD pattern of ZnO NPs, the average size of ZnO NPs is 25 nm.
- (d) XRD pattern of TiO_2 NPs, the average size of TiO_2 NPs is 23 nm.



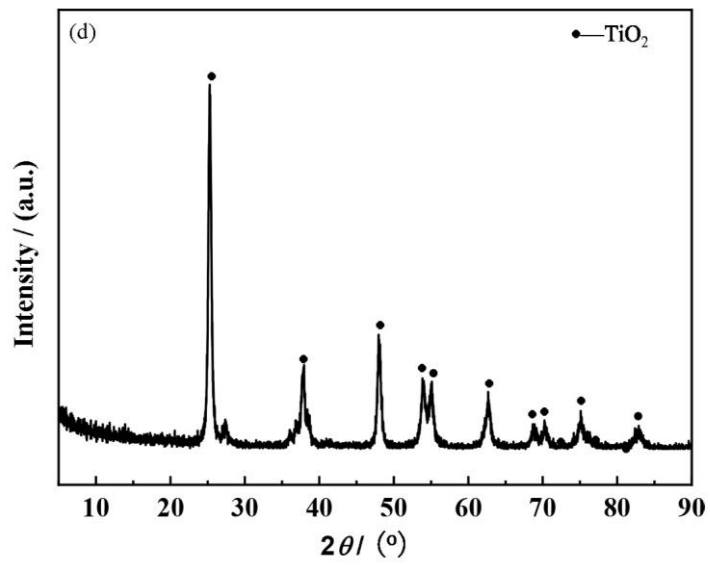
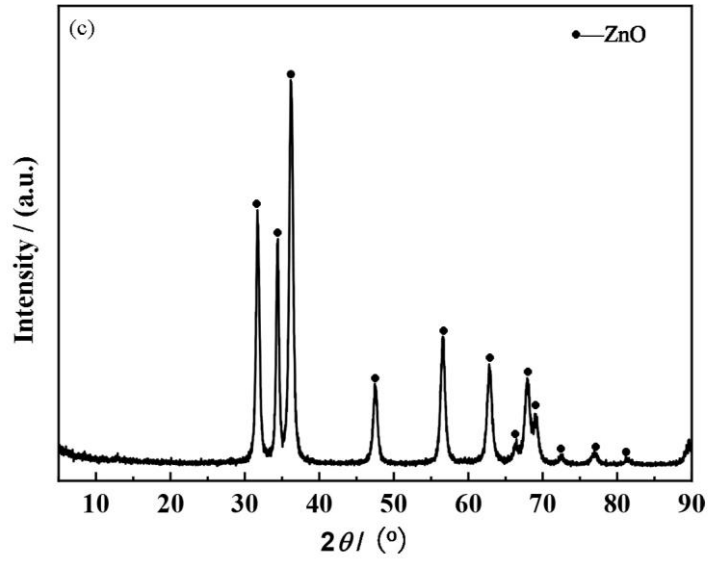


Fig. S2. XRD pattern of Al₂O₃ nanoparticles (NPs) (a), XRD pattern of Fe₃O₄ NPs (b), XRD pattern of ZnO NPs (c), XRD pattern of TiO₂ NPs (d).

Part S3 Curve-fitting of second derivative spectra for TB-EPS and LB-EPS

0-LB Curve-fitting of second derivative spectra for LB-EPS.

0-TB Curve-fitting of second derivative spectra for TB-EPS.

a-LB When sludge is treated with 0.04g/g TSS Al₂O₃ NPs, the Curve-fitting of second derivative spectra for LB-EPS.

a-TB When sludge is treated with 0.05g/g TSS Al₂O₃ NPs, the Curve-fitting of second derivative spectra for TB-EPS.

b-LB When sludge is treated with 0.05g/g TSS Fe₃O₄ NPs, the Curve-fitting of second derivative spectra for LB-EPS.

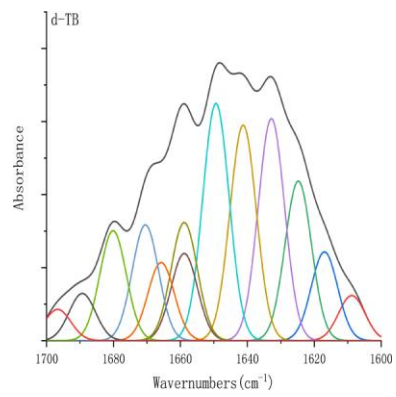
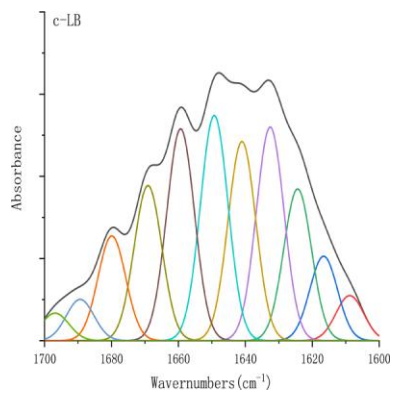
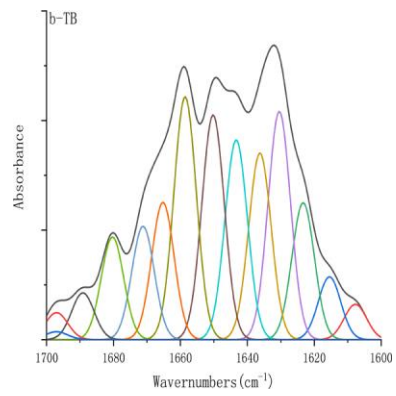
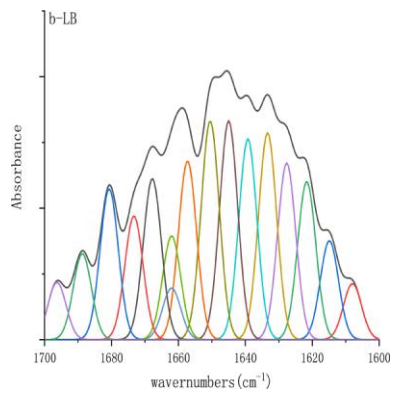
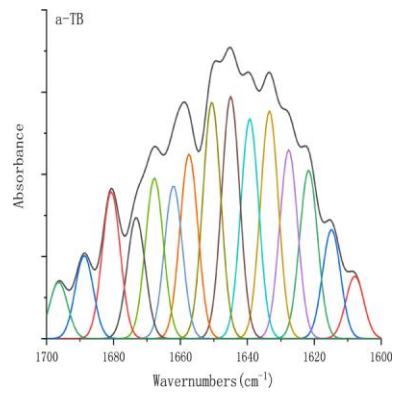
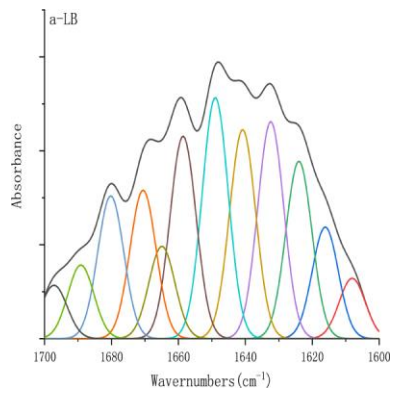
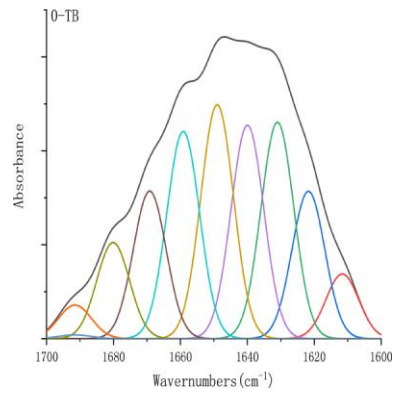
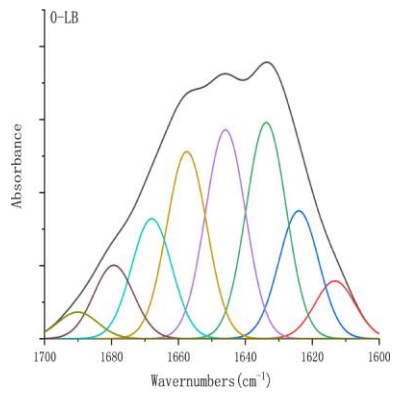
b-TB When sludge is treated with 0.05g/g TSS Fe₃O₄ NPs, the Curve-fitting of second derivative spectra for TB-EPS.

c-LB When sludge is treated with 0.05g/g TSS ZnO NPs, the Curve-fitting of second derivative spectra for LB-EPS.

c-TB When sludge is treated with 0.05g/g TSS ZnO NPs, the Curve-fitting of second derivative spectra for TB-EPS.

d-LB When sludge is treated with 0.03g/g TSS TiO₂ NPs, the Curve-fitting of second derivative spectra for LB-EPS.

d-TB When sludge is treated with 0.03g/g TSS TiO₂ NPs, the Curve-fitting of second derivative spectra for TB-EPS.



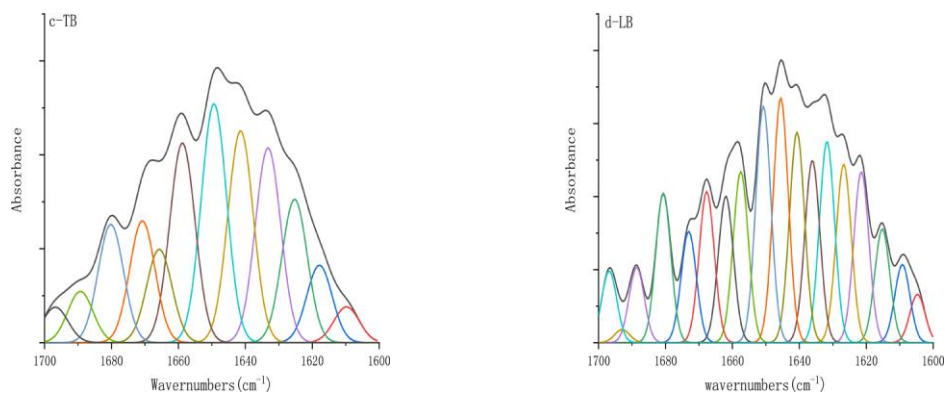


Fig. S3. Curve-fitting of second derivative spectra for extracellular polymeric substances (EPS). Blank samples (0), Al₂O₃ nanoparticles (NPs) treated sludge (0.04 g/g TSS) (a), Fe₃O₄ NPs treated sludge (0.05 g/g TSS) (b), ZnO NPs treated sludge (0.05 g/g TSS) (c), TiO₂ NPs treated sludge (0.03 g/g TSS) (d). TSS = total suspended solid.