The Uptake of Engineered Nanoparticles by Sludge Particulates

Soohoon Choi [1,2,*], Murray Johnston [3], Gen-Shuh Wang [4] and Chin-Pao Huang [1]

[1] Department of Civil and Environmental Engineering, University of Delaware, Newark, DE 19711, USA
[2] Department of Environmental Engineering, Chungnam University, 99 Daehak-ro, Yuseong-gu, Daejeon 34134, Korea
[3] Department of Chemistry and Biochemistry, University of Delaware, Newark, DE 19711, USA
[4] Institute of Environmental Health, National Taiwan University, Taipei 100, Taiwan; gswang@ntu.edu.tw
* Correspondence: crimson@cnu.ac.kr

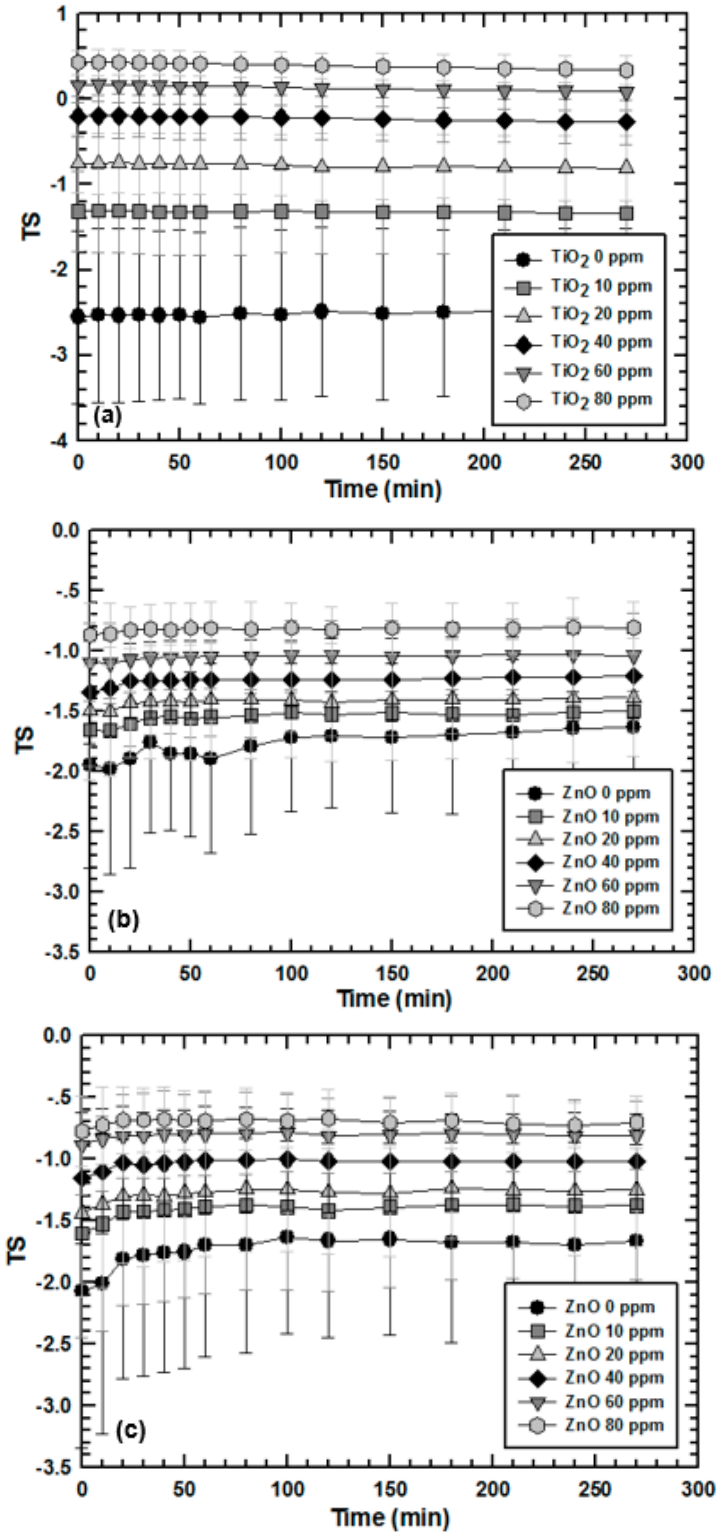


Figure S1. Sedimentation profile of Zn and TiO_2 with DOM. Primary DOM = 400mg/L, Secondary DOM = 250 mg/L. Reaction time 5hr. pH= 6.8. The x–axis indicates the sedimentation time, where the y-axes (TS) indicates the turbidity of the sludge (a) Secondary DOM + TiO_2. (b) Primary DOM + ZnO (c) Secondary DOM + ZnO.

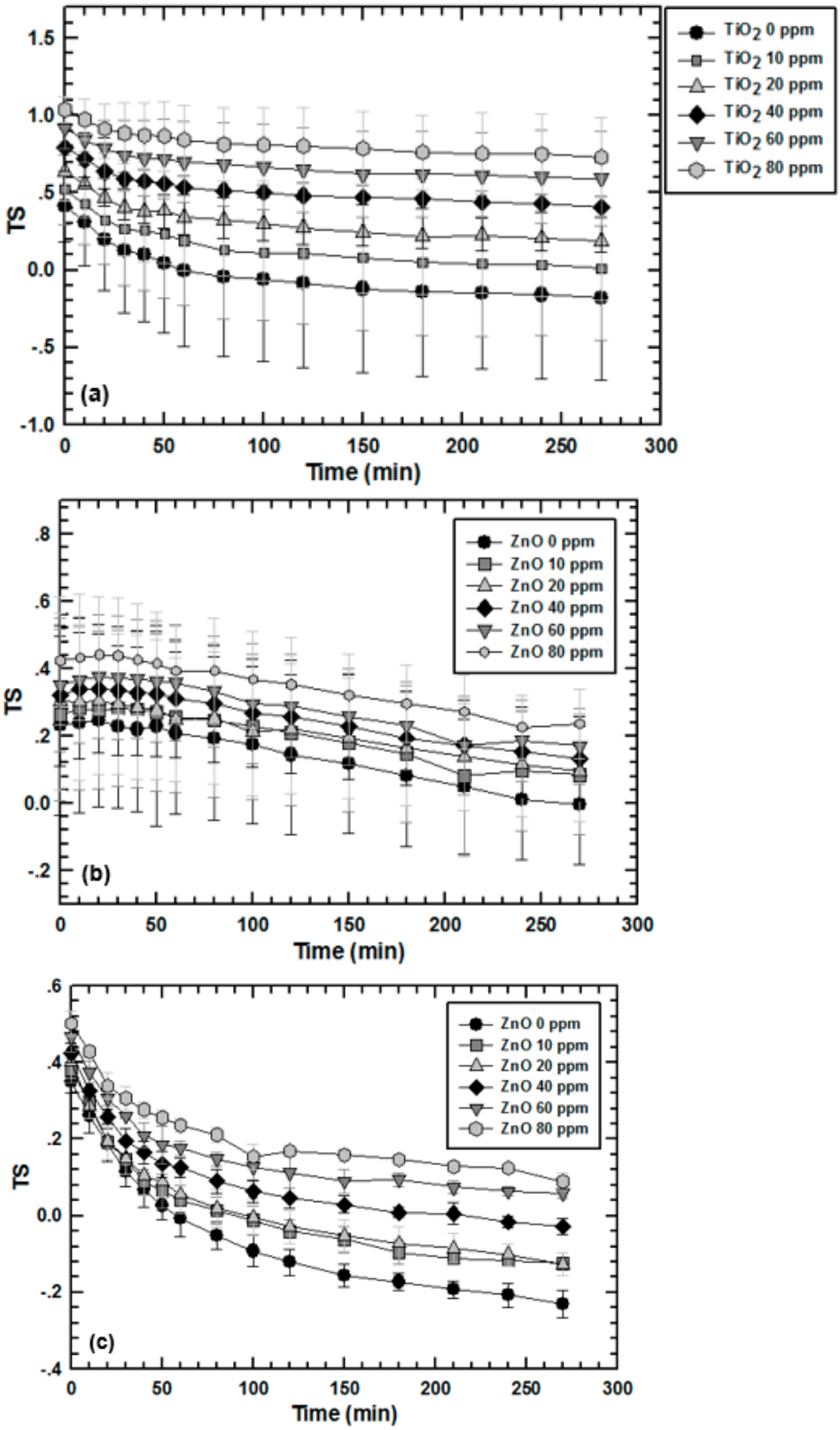


Figure S2. Sedimentation profile of ZnO and TiO_2 with supernatant (small organic matter <1μm). Primary supernatant = 567 mg/L. Reaction time 5hr. pH = 6.8 (a) Secondary supernatant + TiO_2. (b) Primary supernatant + ZnO (c) Secondary supernatant + ZnO.

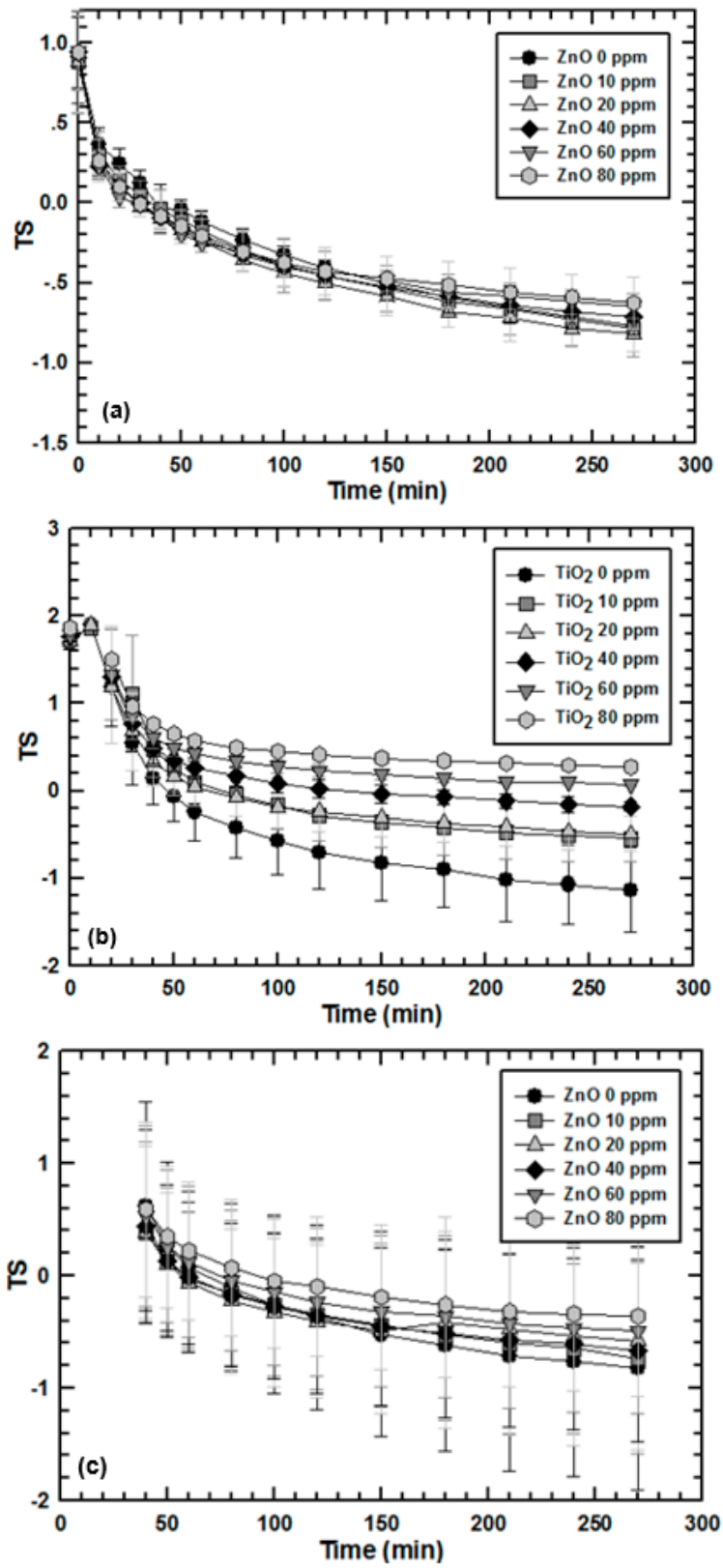


Figure S3. Sedimentation profile of Zn and TiO_2 with large organic particles (>1μm). Primary = 2242 mg/L, Secondary = 6100 mg/L. Reaction time 5hr. pH= 6.8 (a) Primary + ZnO (b) Secondary + TiO_2. (c) Secondary + ZnO

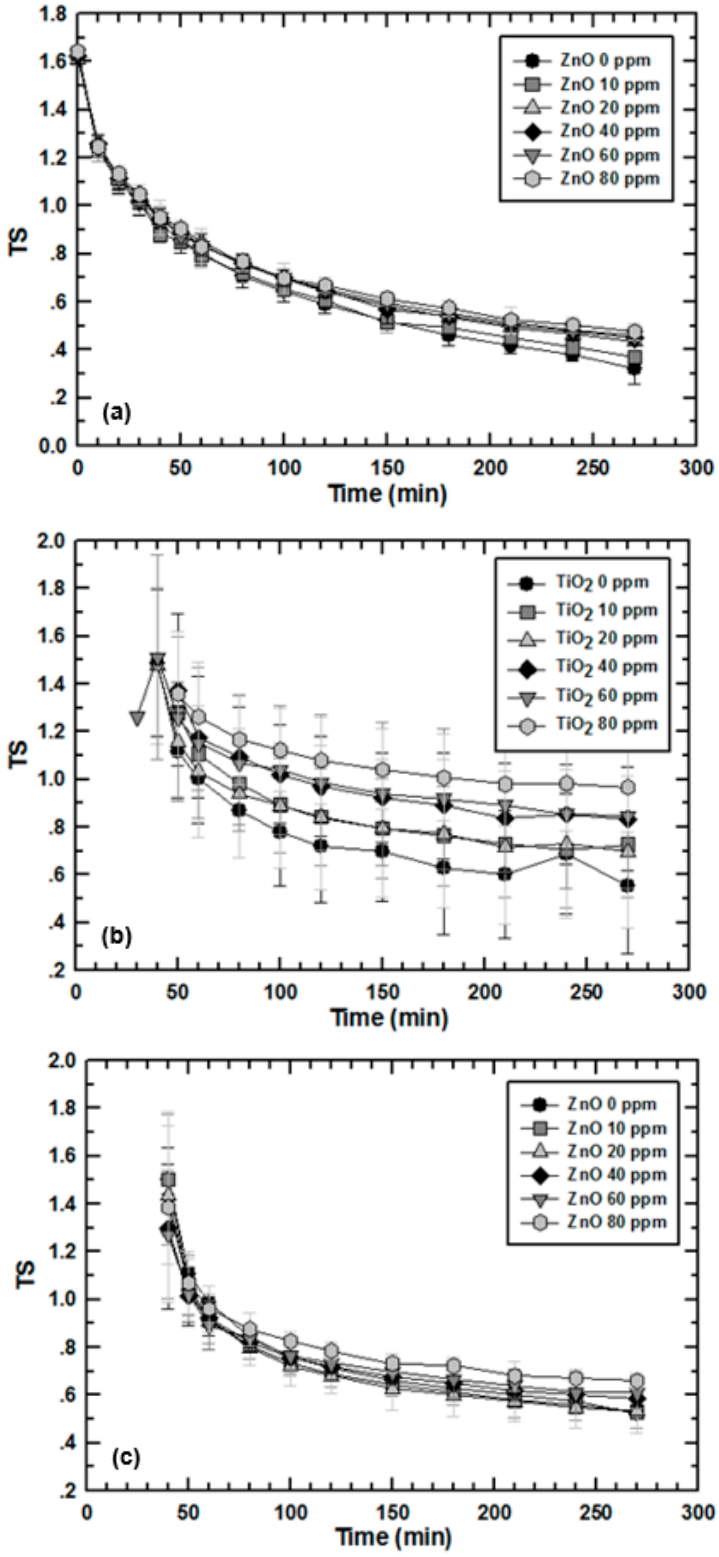
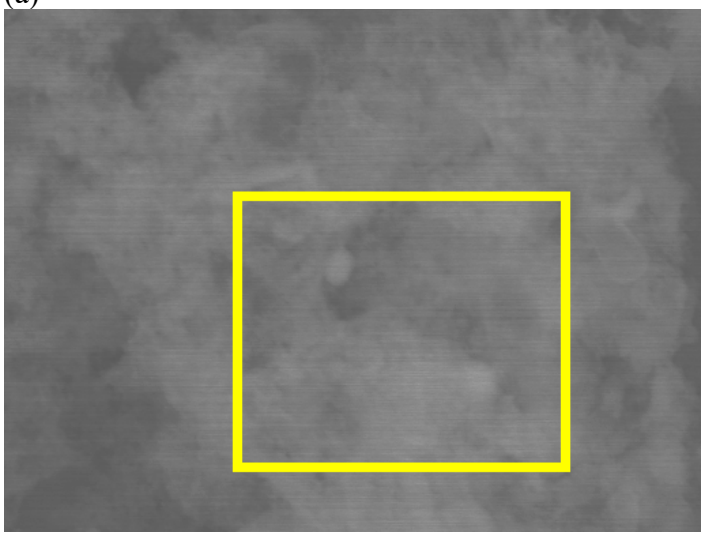
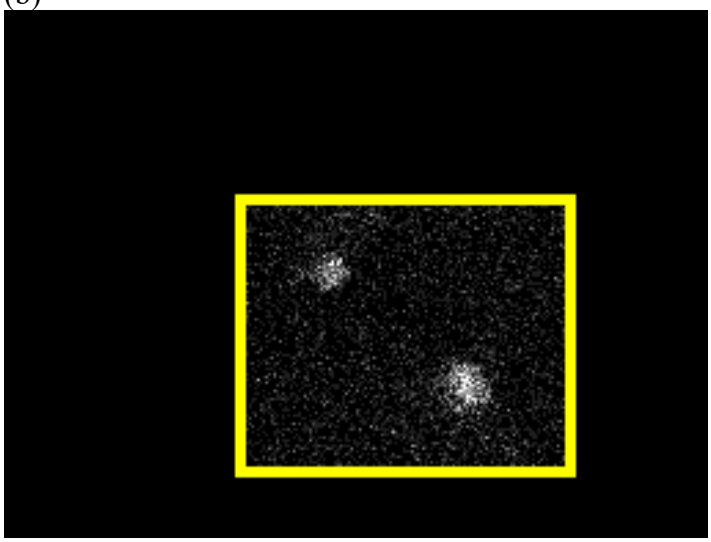


Figure S4. Sedimentation profile of Zn and TiO_2 with sludge. Primary = 2942 mg/L, Secondary = 6667 mg/L. Reaction time 5hr. pH= 6.8 (a) Primary sludge + ZnO (b) Secondary sludge + TiO_2. (c) Secondary sludge + ZnO

(a)



(b)



(c)

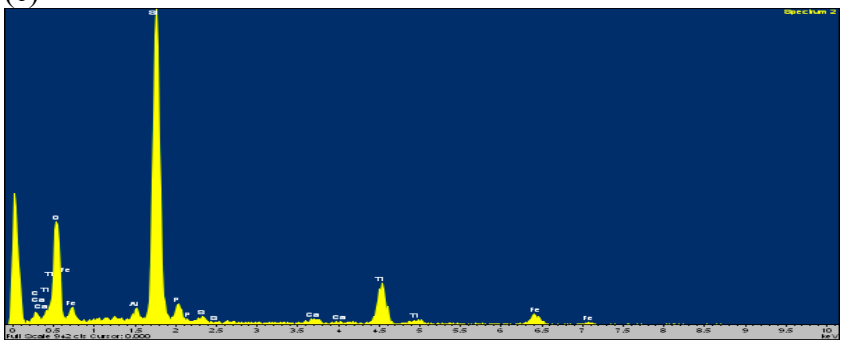
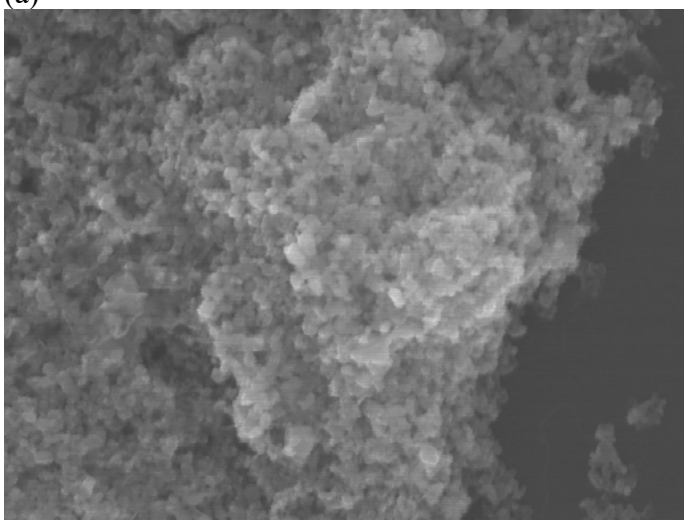
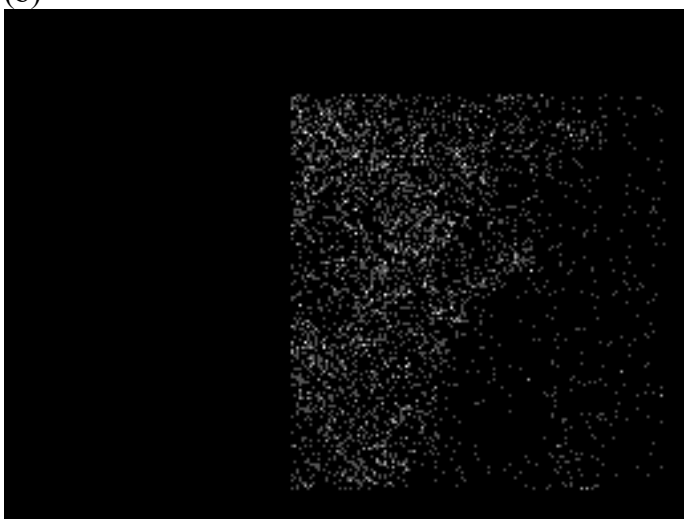


Figure S5. SEM image and EDS analysis of TiO_2 sorption to sludge particulates (a) SEM image of TiO_2 attached to sludge particulates, (b) elemental analysis of Titanium from the SEM image from image (a), (c) Energy dispersive spectroscopy (EDS) analysis of the particular matter in image (a).

(a)



(b)



(c)

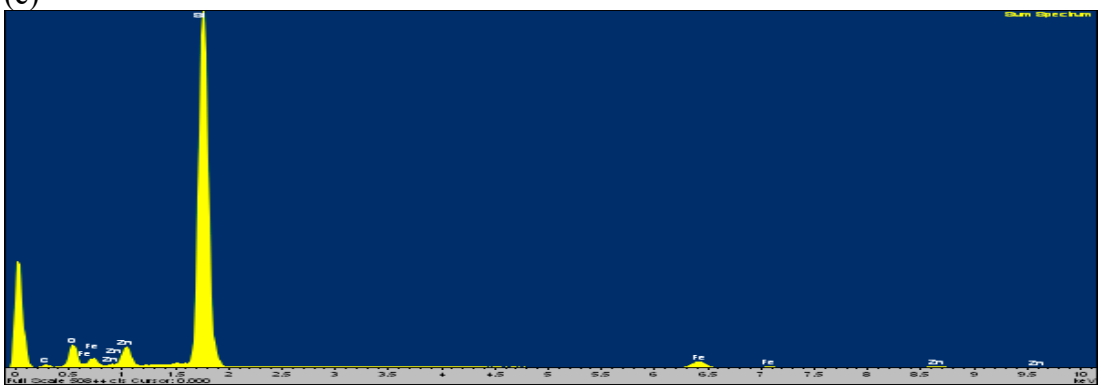
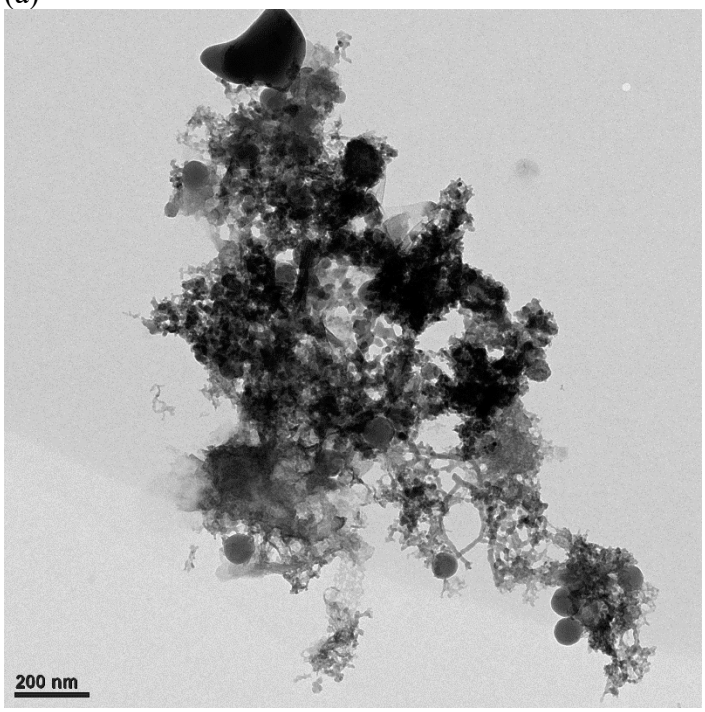


Figure S6. SEM image and EDS analysis of ZnO sorption to sludge particulates (a) SEM image of ZnO attached to sludge particulates, (b) elemental analysis of Zinc from the SEM image from image (a), (c) Energy dispersive spectroscopy (EDS) analysis of the particular matter in image (a).

(a)



(b)

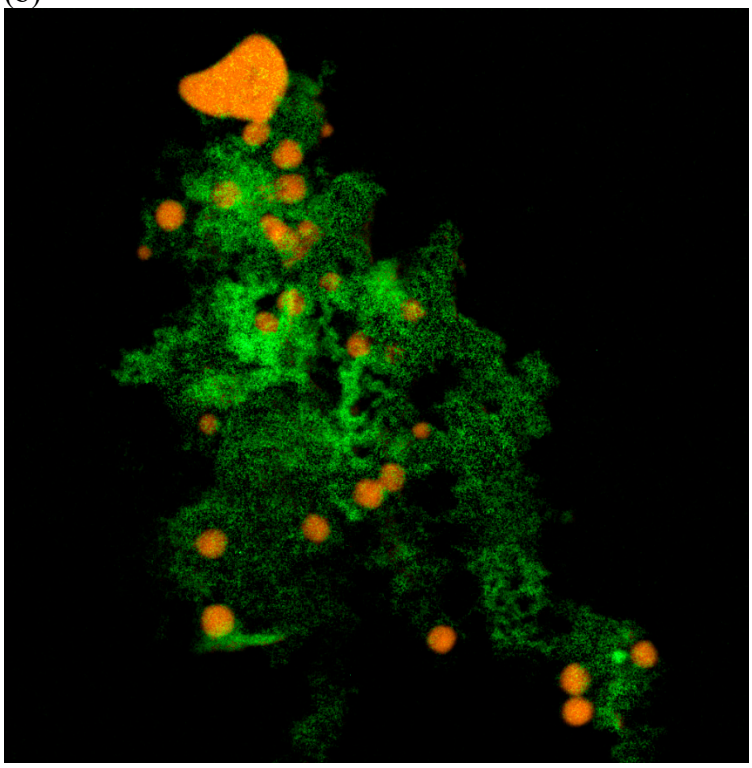


Figure S7. TEM image and EDS analysis of SiO_2 sorption to sludge particulates (a) TEM image of SiO_2 attached to sludge particulates, (b) elemental analysis of silica from the TEM image from image (a), the green images indicate organic matter where orange images indicate elemental silica.