Supplementary Data

Section 1 Exprimental section

Table S1 Physical-chemical characteristics of three test waters used in this study

Water samples	Turbidity (NTU)	pH	UV_{254} (cm^{-1})	DOC (mg/L)	SUVA (L/mg·m)	OD_{680}	Zeta potential (mV)
YW	1.38±0.5	8.43±0.2	0.040±0.004	5.57±0.02	0.71±0.2	-	-23.12±1
MA-YW	11.4±0.5	8.57±0.2	0.053±0.004	6.96±0.02	0.76±0.2	0.035±0.005	-28.23±1
MW-YW	15.6±0.5	8.47±0.2	0.048±0.004	6.59±0.02	0.73±0.2	0.026±0.005	-29.67±1

Detailed analytic process:

Supernatant samples through 0.45 μm microporous membrane (Xin Ya purification Equipment, China) were for UV_{254} absorbance measurement using a ultraviolet-visible spectrophotometer (TU-1810PC, Persee, China) at 254 nm, and dissolved organic carbon (DOC) were measured using a TOC analyzer (TOC-VCPH, Shimadzu, Japan). OD_{680} represents the concentration of algae at 680 nm, which was measured immediately after sampling by using a ultraviolet-visible spectrophotometer. Specific UV absorbance (SUVA) was calculated using Eq. (1):

$$SUVA = \frac{UV_{254}}{DOC} \times 100\% \quad (1)$$

Turbidity, pH value and floc zeta potential were directly measured by using a turbidimeter (2100Q, Hach, USA), a pH meter (pHS-3C, Leici, China), a zetasizer (Nano-ZS90, Malvern Instrument, UK), respectively.

Section 2 Results and discussion

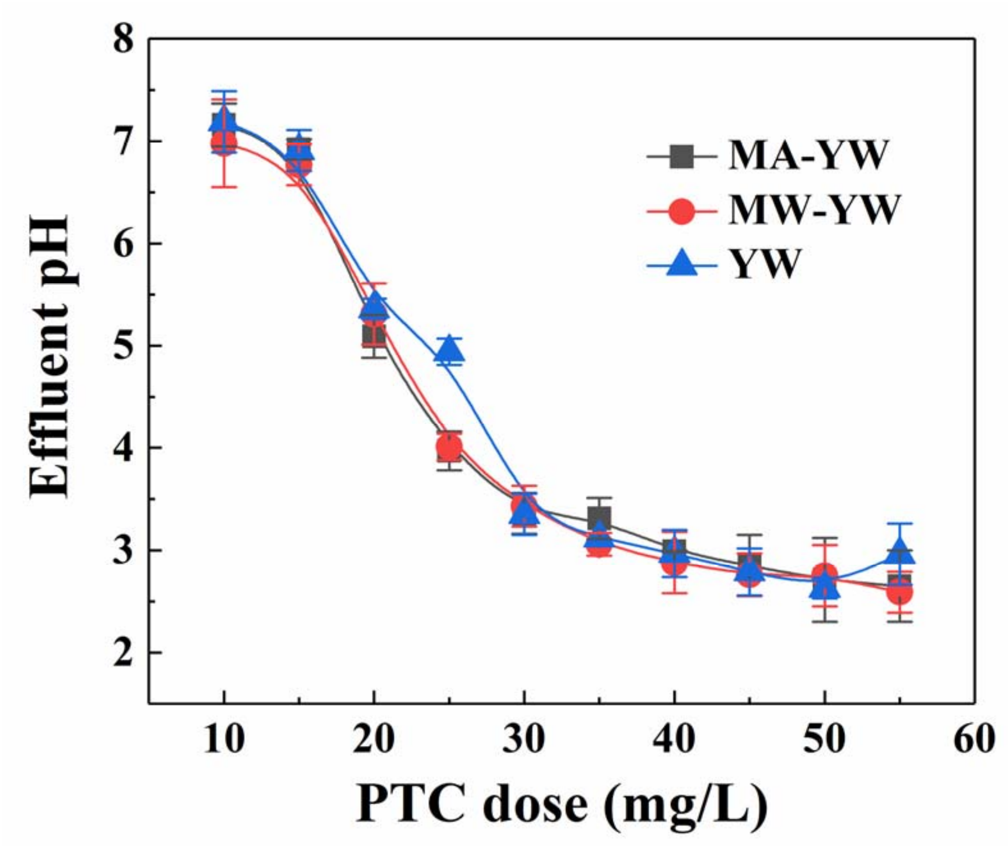

Fig. S1 Effect of coagulation dosage on effluent pH. (Initial pH 8.5; PTC: polytitanium chloride; YW: Yellow River water; MA-YW: Microcystis aeruginosa-laden Yellow River water; MW-YW: Microcystis wesenbergii-laden Yellow River water)

Fig. S1 presented the effect of PTC coagulant dosage on coagulation performance in terms of the effluent pH for the treatment of the three water samples (YW, MA-YW and MW-YW), and the observation was that, the effluent pH decreased gradually with the increase in PTC dosage and the algae had little effect on the pH of the effluent. In general, change of water pH was generally caused by the hydrolysis of the coagulant during coagulation procedure. Herein, it can conclude that algae may not influence the hydrolysis of PTC.

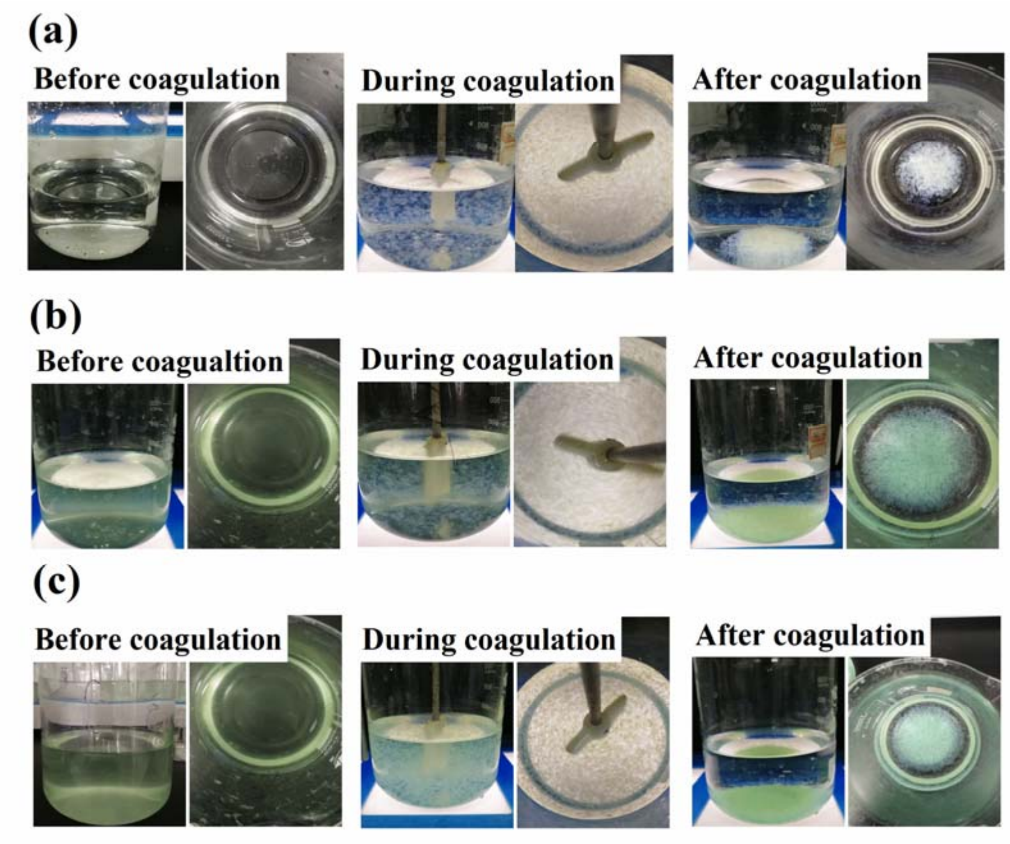

Fig. S2 Side and top view pictures before coagulation, during coagulation, and after coagulation: (a) YW case; (b) MA-YW case; (c) MW-YW case. (PTC dosage of 35 mg/L conditions; PTC: polytitanium chloride; YW: Yellow River water; MA-YW: Microcystis aeruginosa-laden Yellow River water; MW-YW: Microcystis wesenbergii-laden Yellow River water)

Side and top view pictures before coagulation, during coagulation, and after coagulation for tested water samples are shown in Fig. S2. During PTC coagulation, it was found that, after slow stirring for a certain period of time, a large number of flocs appeared for all three water samples cases. After coagulation, the flocs can finish the sedimentation in a short time, resulting in clear supernatant. Thus, it can conclude that the presence of algae had little effect on the growth rate and sedimentation performance of flocs, which still needed further research.

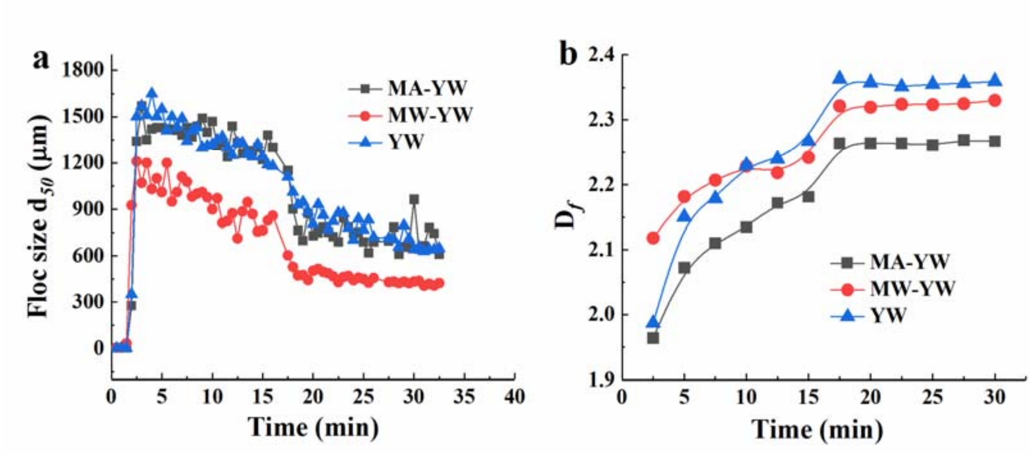

Fig. S3 PTC coagulation of YW, MA-YW and MW-YW: (a) floc growth, breakage and regrowth profiles and (b) variation of floc fractal dimension (D_f) vs. coagulation period. (Initial pH 8.5; PTC dose of 35 mg/L; PTC: polytitanium chloride; YW: Yellow River water; MA-YW: Microcystis aeruginosa-laden Yellow River water; MW-YW: Microcystis wesenbergii-laden Yellow River water; d_{50}: the median volumetric diameter)

The variation of floc characteristics vs. coagulation period in terms of floc size and fractal dimension (D_f) at PTC dosage of 35 mg/L was investigated, and the results are shown in Fig. S3. It was found that the floc size produced in MW-YW case (907 μm) was much smaller than that produced in MA-YW (1343 μm) and YW case (1296 μm), and no regrowth was observed in all water samples, indicating that sweep flocculation would be the dominant coagulation mechanism during the water treatment of these three water samples at PTC dosage of 35 mg/L (Chekli et al., 2017). Besides, as shown in Fig. S3 (b), the floc D_f increased significantly after the shear force was introduced, which demonstrated that the flocs were broken upon exposure to high shear, resulting in the formation of more stable structures flocs (Rong et al., 2013).

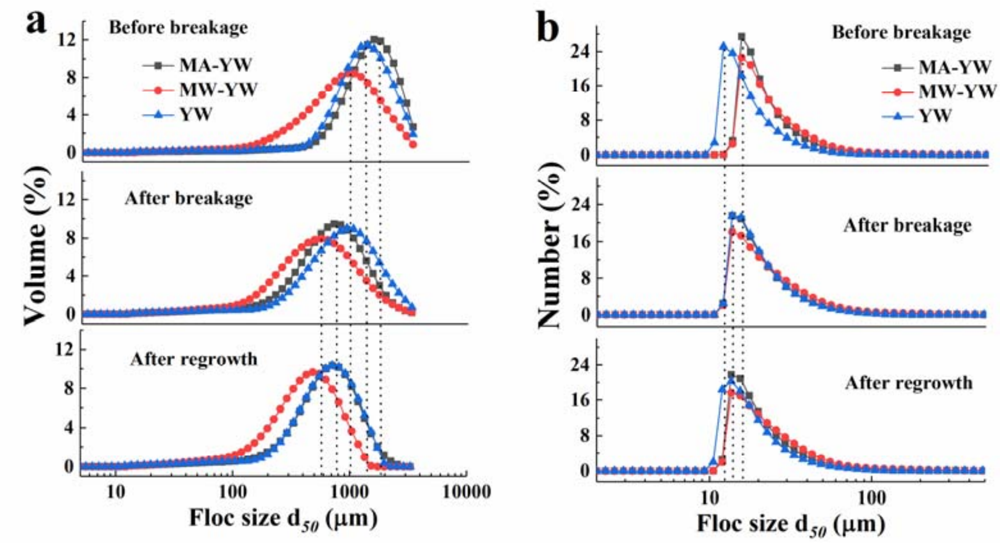

Fig. S4 Size distribution of the particles formed by PTC in cases of YW, MA-YW and MW-YW: (a) volume-based PSD and (b) number-based PSD. (Initial pH 8.5; PTC: polytitanium chloride; YW: Yellow River water; MA-YW: Microcystis aeruginosa-laden Yellow River water; MW-YW: Microcystis wesenbergii-laden Yellow River water; PSD: particle size distribution; d_{50}: the median volumetric diameter)

Fig. S4 showed the volume-based particle size distribution (PSD) and number-based PSD of the three water samples before, after breakage and after regrowth. Before breakage, the size of flocs in PTC coagulated effluent in YW and MA-YW cases ranged from 600 to 3000 μm (Fig. S4), while the size of floc formed in MW-YW case ranged from 100 to 3000 μm. And, it was obvious that for MW-YW case, the volume percentage at the peak was much smaller than for YW and MA-YW cases. After breakage, there was an slight shift in the major peak to the left of the original value for MA-YW and MW-YW compared to YW, which further indicated that the flocs produced by these two water samples treatment had a weaker ability to resist shear force. Besides, irreversibility breakage was observed in all three water samples cases after regrowth.

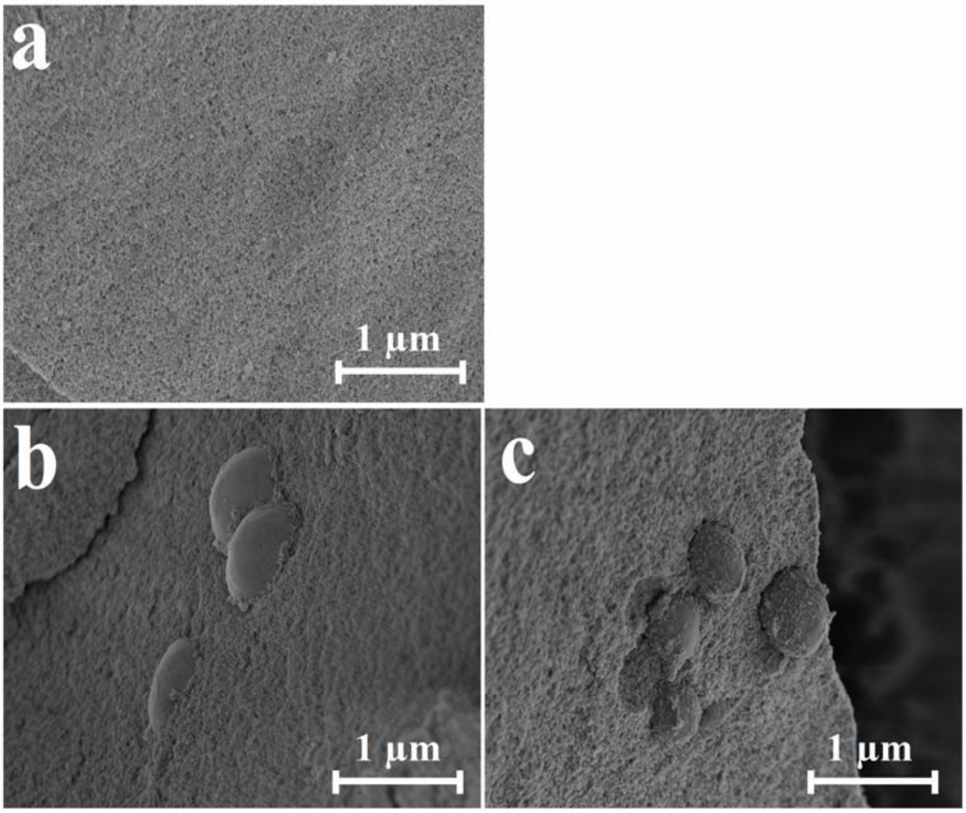

Fig. S5 The SEM images of the coagulated flocs: (a) YW case; (b) MA-YW case; (c) MW-YW case.

(YW: Yellow River water; MA-YW: Microcystis aeruginosa-laden Yellow River water; MW-YW: Microcystis wesenbergii-laden Yellow River water)

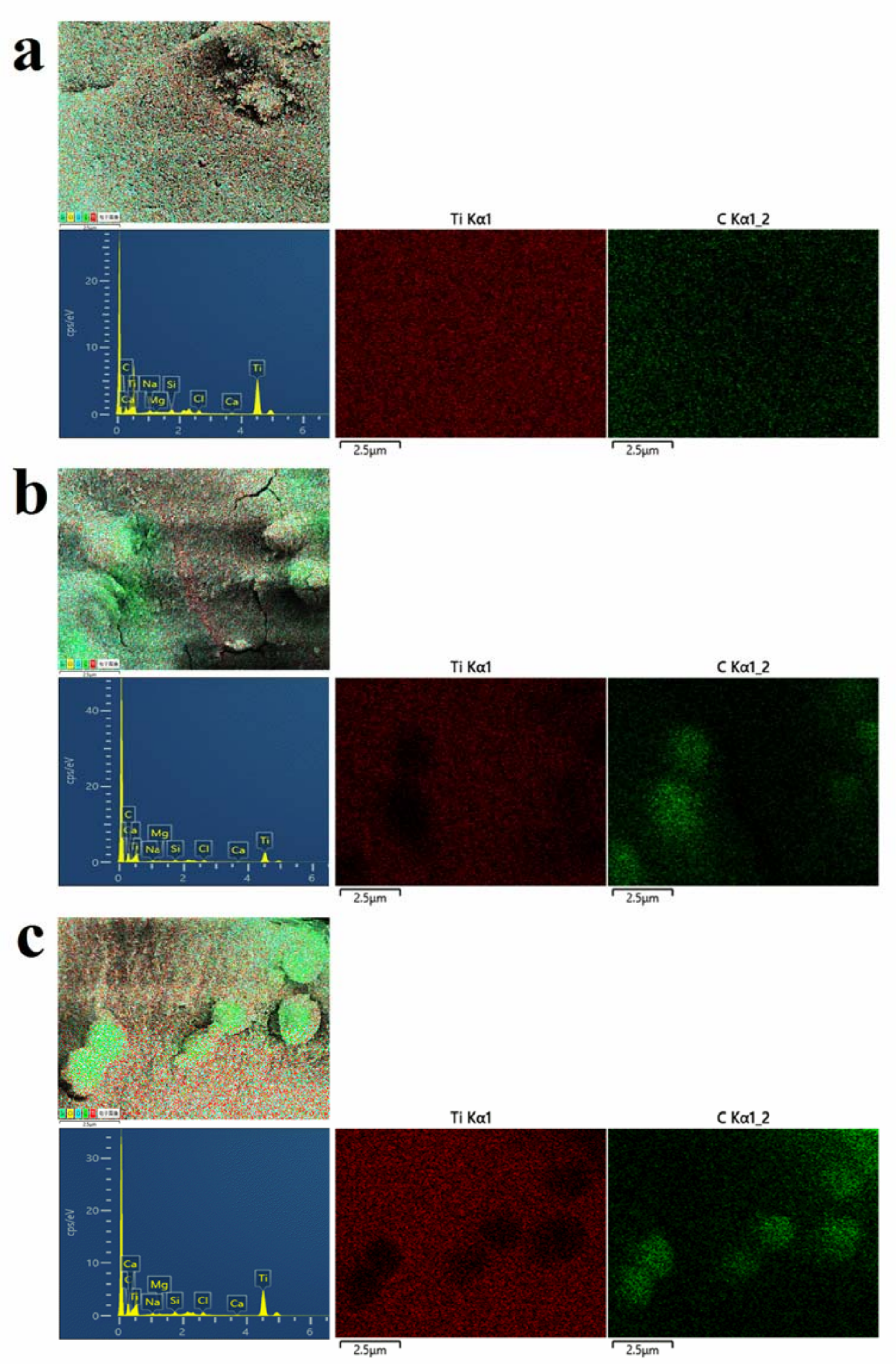

Fig. S6 The EDS images and mapping of the coagulated flocs: (a) Yellow River water (YW) case; (b) Microcystis aeruginosa-laden Yellow River water (MA-YW) case; (c) Microcystis wesenbergii-laden Yellow River water (MW-YW) case.

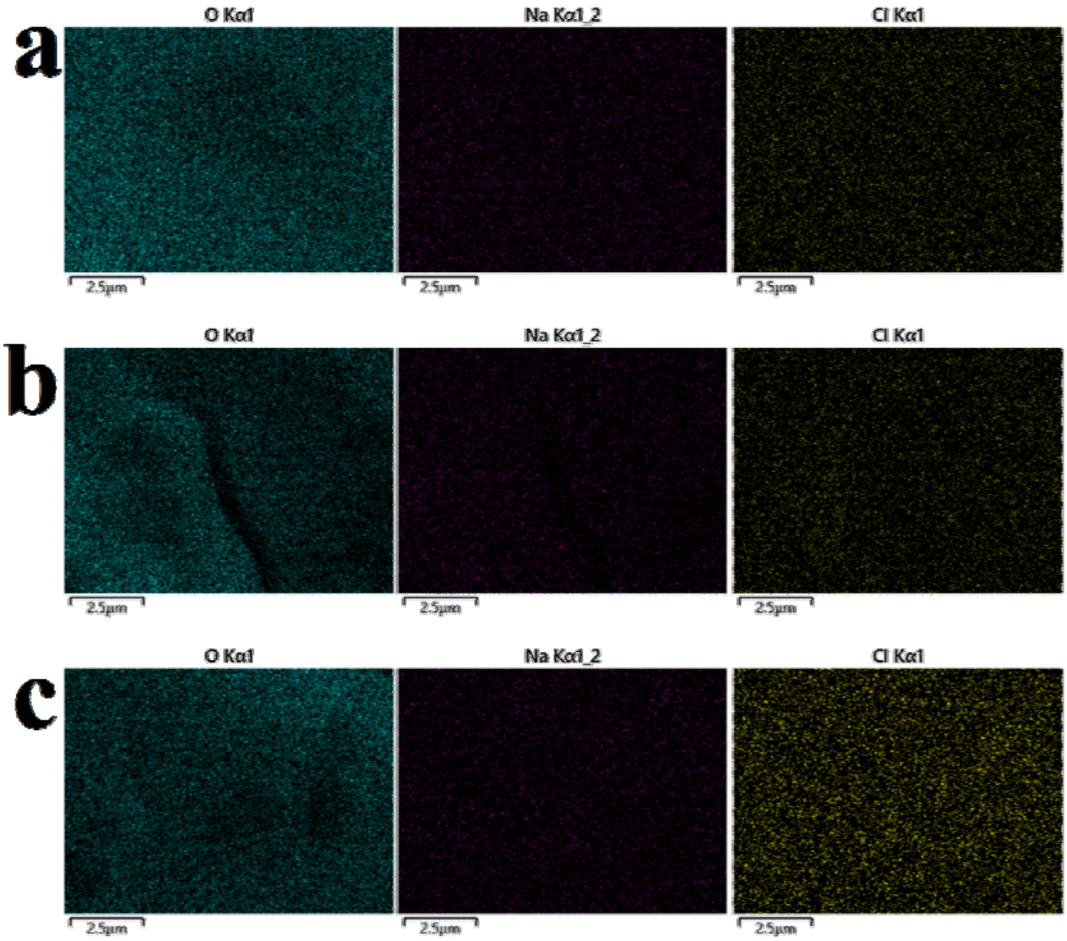

Fig. S7 The mapping of the coagulated flocs: (a) Yellow River water (YW) case; (b) Microcystis aeruginosa-laden Yellow River water (MA-YW) case; (c) Microcystis wesenbergii-laden Yellow River water (MW-YW) case.

Fig.S7 showed the of O, Na and Cl elements on flocs and algae cell surface. It can be found that, these three elements were distributed on the surface of both flocs and algae cells, which was obviously different from the distribution of titanium, that is, it was only distributed on the surface of flocs that did not contain algal cells.

References

Chekli L, Eripret C, Park S H, Tabatabai S A A, Vronska O, Tamburic B, Kim J H, Shon H K (2017).

Coagulation performance and floc characteristics of polytitanium tetrachloride (PTC) compared with titanium tetrachloride ($TiCl_4$) and ferric chloride ($FeCl_3$) in algal turbid water. Separation and Purification Technology, 175: 99-106

Rong H Y, Gao B Y, Dong M, Zhao Y X, Sun S L, Yan W, Yue Q Y, Li Q (2013). Characterization of size, strength and structure of aluminum-polymer dual-coagulant flocs under different pH and hydraulic conditions. Journal of Hazardous Materials, 252-253: 330-337