

Scheme 1S. Scheme procedure of preparation process for H-Cu-Al/BC

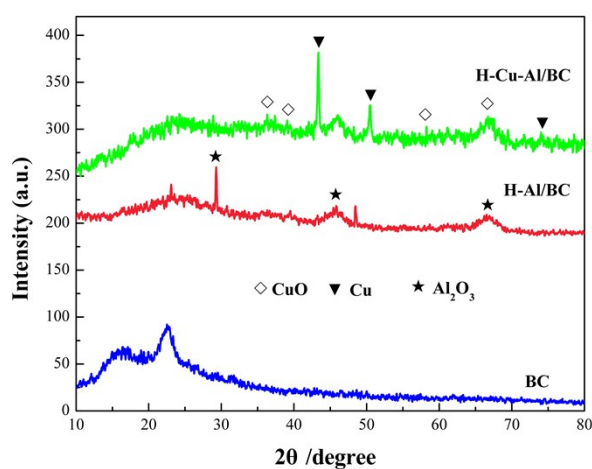


Fig. S1. X-ray diffraction of the prepared materials

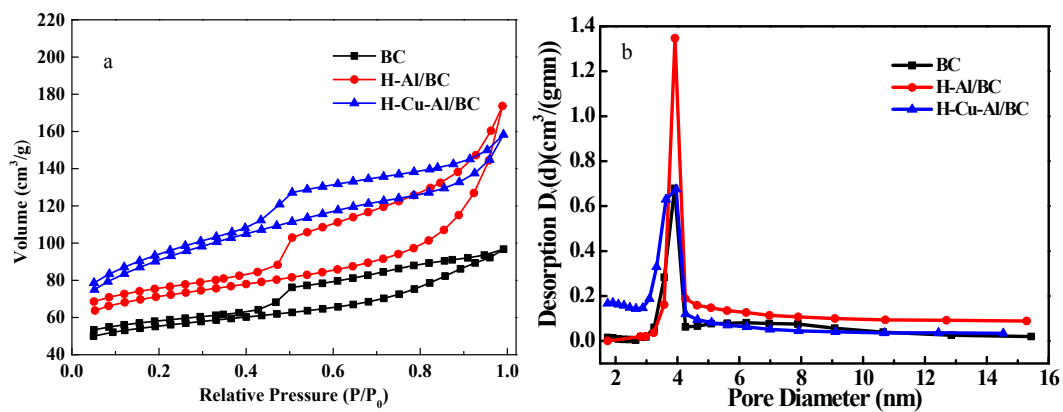


Fig.S2. N<sub>2</sub> sorption/desorption isotherms of three prepared samples (a. nitrogen adsorption/desorption isotherms; b. Pore size distributions by BJH method)

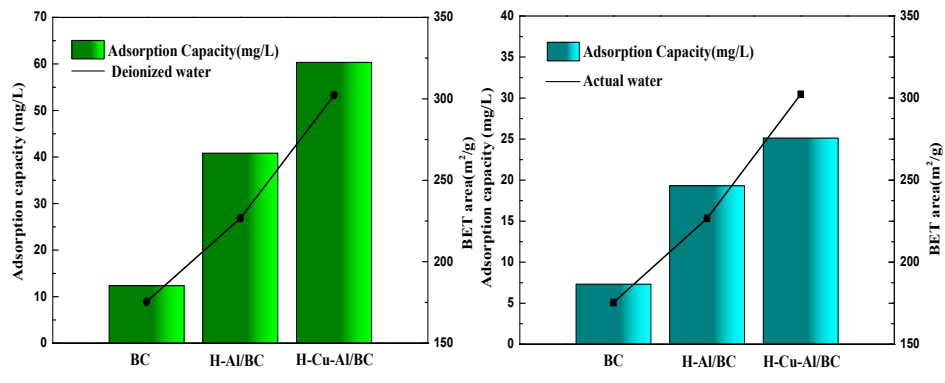


Fig.S3. The mutual relation of the adsorption capacity and BET areas under different water quality conditions

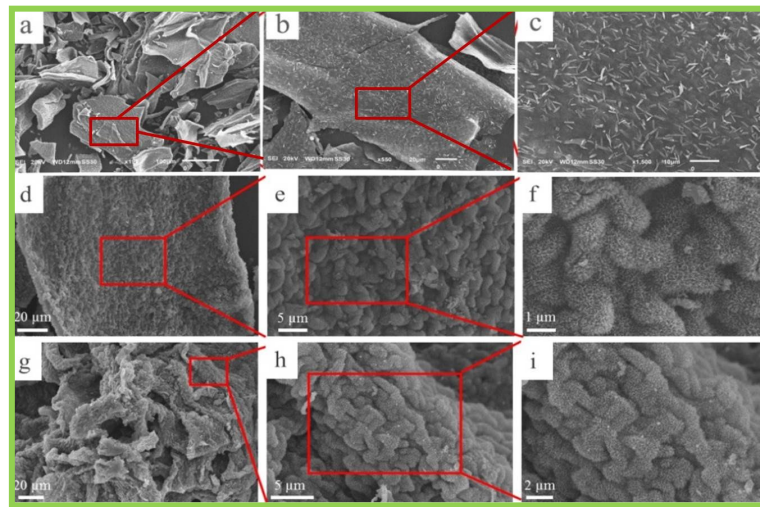


Fig. S4. SEM of BC (a, b, c), H-Al/BC (d, e, f) and H-Cu-Al/BC (g, h, i) at three different magnifications

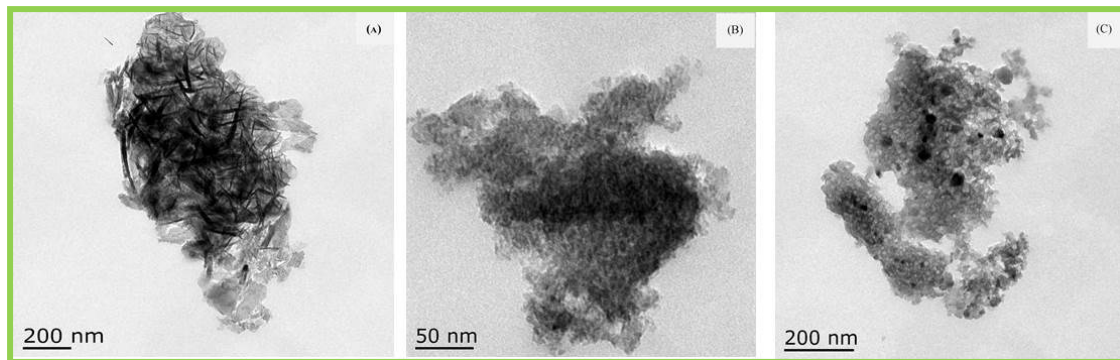


Fig. S5. TEM of BC (A), H-Al/BC (B) and H-Cu-Al/BC (C)

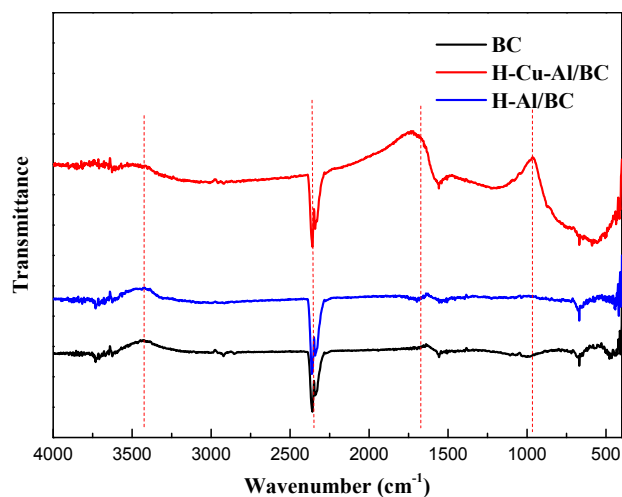
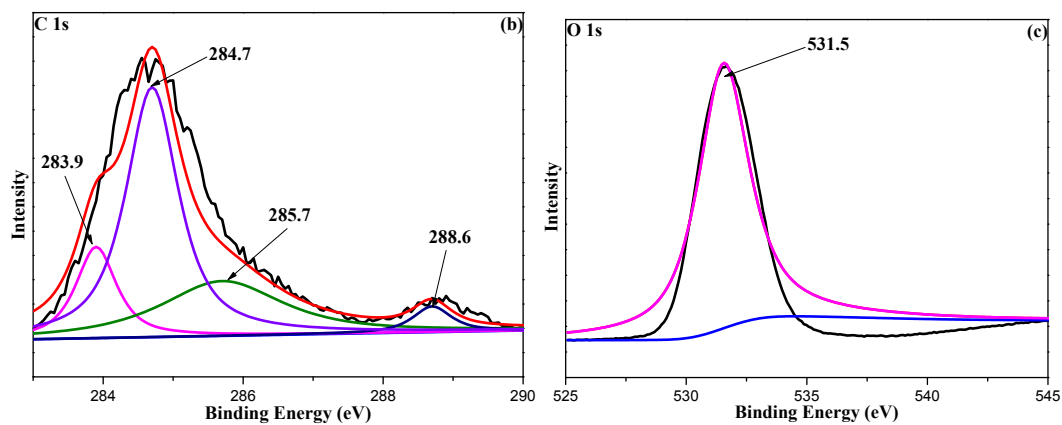
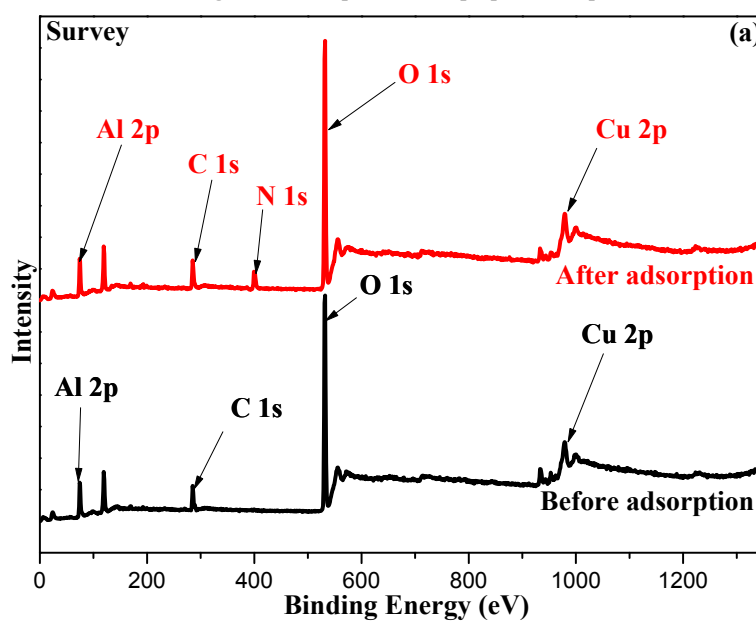


Fig. S6. FTIR spectra of as-prepared samples



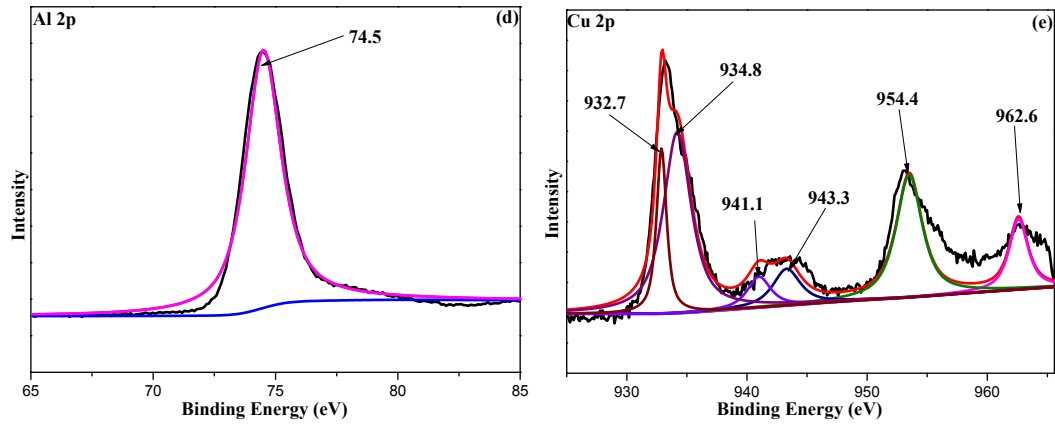


Fig.S7 XPS spectra of H-Cu-Al/BC: (a) survey scan, (b) C 1s, (c) O 1s, (d) Al 2p, (e) Cu 2p.

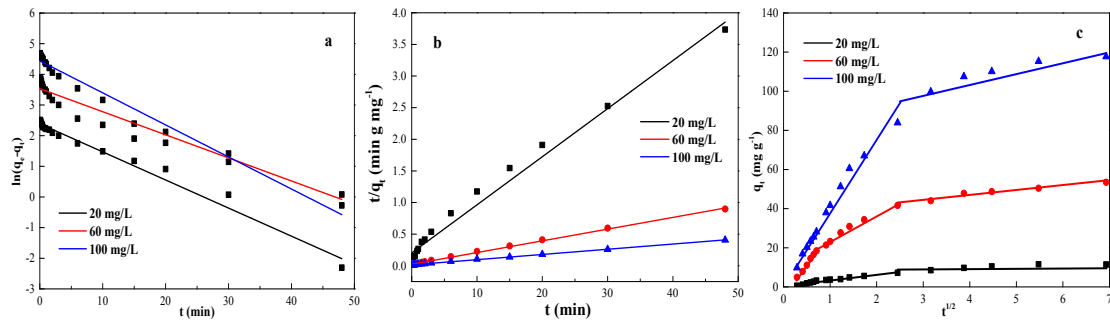


Fig.S8. Adsorption kinetics of  $\text{NH}_4^+\text{-N}$  onto the H-Cu-Al/BC (a) Pseudo-first order kinetics; (b) Pseudo-second order kinetics; (c) and intraparticle diffusion

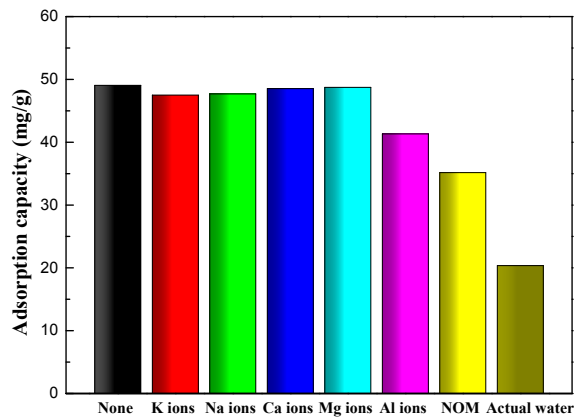


Fig. S9. Effect of co-anions and NOM on the adsorption process

Table 1S The pore textural characteristics of all prepared samples

Samples	$S_{\text{BET}}$ ( $\text{m}^2/\text{g}$ )	$V_{\text{T}}$ ( $\text{m}^3/\text{g}$ )	$V_{\text{mes}}$ ( $\text{cm}^3/\text{g}$ )	$D_{\text{p}}$ (nm)	HF ( $V_{\text{mes}}/V_{\text{T}}$ )
BC	175.4	0.15	0.08	5.04	0.53
H-Al/BC	226.7	0.27	0.19	4.74	0.70
H-Cu-Al/BC	302.3	0.24	0.16	3.94	0.63

$S_{\text{BET}}$ =BET surface area;  $V_{\text{T}}$ =total pore volume;  $D_{\text{p}}$ =average pore diameter.

Table 2S Isotherms parameters and correlation coefficients of  $\text{NH}_4^+\text{-N}$  onto the as-prepared materials

Adsorbent	Adsorption isotherms								
	Langmuir			Freundlich			Temkin		
	Q <sub>m</sub> (mg/g)	K <sub>L</sub> (L/mg)	R <sup>2</sup>	K <sub>F</sub> (mg/g)	n	R <sup>2</sup>	B	A (L/mg)	R <sup>2</sup>
BC	15.46	0.021	0.998	18.5	11.4	0.873	0.38	21.4	0.991
H-Al/BC	37.65	0.037	0.999	47.4	17.5	0.914	0.54	54.8	0.936
H-Cu-Al/BC	81.54	0.045	0.999	101.7	11.3	0.878	0.77	114.5	0.918

**Table 3S** Kinetic parameters for NH<sub>4</sub><sup>+</sup>-N adsorption onto the H-Cu-Al/BC

Concentration (mg/L)	pseudo-first order			pseudo-second order			intraparticle diffusion		
	q <sub>e</sub>	k <sub>1</sub>	R <sup>2</sup>	1/k <sub>2</sub> q <sub>e</sub> <sup>2</sup>	q <sub>e</sub>	R <sup>2</sup>	C	k <sub>p</sub>	R <sup>2</sup>
20	25.24	0.0775	0.9806	0.2038	13.15	0.9909	1.5405	1.8445	0.9493
60	62.07	0.0829	0.86	0.0235	54.05	0.9989	13.706	7.0618	0.8115
100	88.49	0.1189	0.9703	0.0142	121.95	0.9988	21.626	17.15	0.868

**Table 4S.** Characteristics of individual substance or the simulated actual water

Parameters Pollutant	Mixed concentration	Individual concentration	Standard deviation
	(mg/L)	(mg/L)	(mg/L)
NH <sub>4</sub> <sup>+</sup> -N	40~50 mg/L	40~50 mg/L	5~6 mg/L
NOM (Humic acid)	10~20 mg/L	40~50 mg/L	2~3 mg/L
K <sup>+</sup> ions	10~20 mg/L	40~50 mg/L	2~3 mg/L
Na <sup>+</sup> ions	10~20 mg/L	40~50 mg/L	2~3 mg/L
Ca <sup>2+</sup> ions	10~20 mg/L	40~50 mg/L	2~3 mg/L
Mg <sup>2+</sup> ions	10~20 mg/L	40~50 mg/L	2~3 mg/L
Al <sup>3+</sup> ions	10~20 mg/L	40~50 mg/L	2~3 mg/L