Electronic Supplementary Information (ESI) for Novel Fe_3O_4/HNT@rGO composite via a facile co-precipitation method for the removal of contaminants from aqueous system

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Experimental section

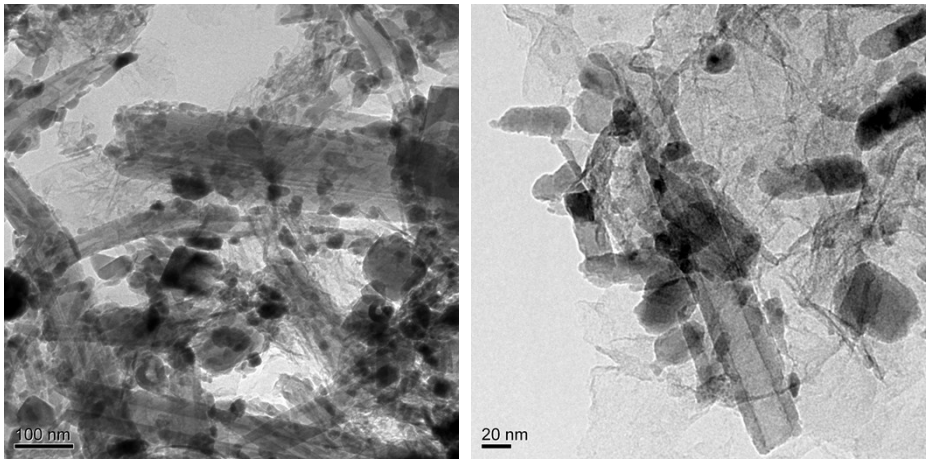
Synthesis of graphene oxide.

Graphene oxide (GO) was synthesized using the following modified Hummer's method.[S1] Graphite (2 g) was mixed with concentrated H_2SO_4 (69 mL) and the mixture was stirred for 30 min within an ice bath. $KMnO_4$ (8 g) was added very slowly into the dark suspension and the reaction mixture was stirred and sonicated for another 15 min under a reaction temperature of 20 °C. Then the ice bath was removed, and the mixture was stirred at 35 °C overnight. Distilled water was added to the pasty solution under magnetic stirring and the color of the solution turned to yellowish brown. After another 2 h of vigorous stirring, H_2O_2 (30*wt* %, 25 mL) was added and the color turned golden yellow immediately. The mixture was washed with HCl (5 %) for several times and then deionized water until the solution became acid free. The

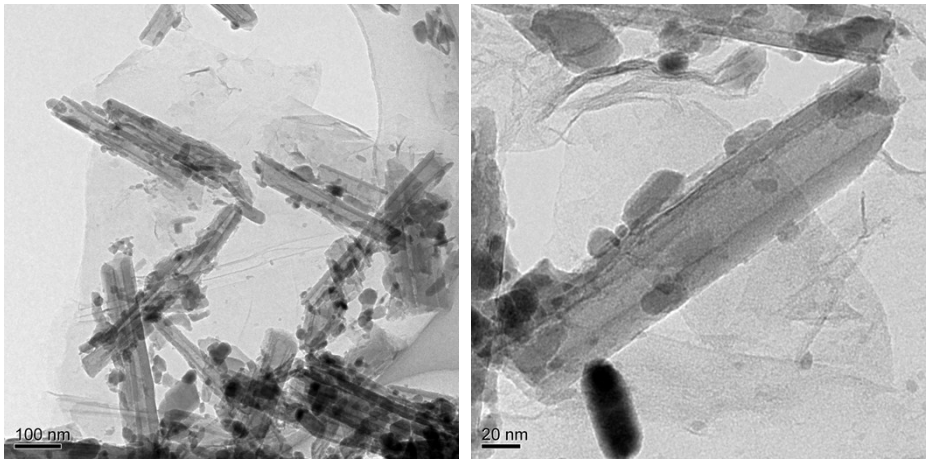
reaction mixture was filtered and dried under vacuum at 65 °C. The GO was obtained as a gray powder and used for the further experimental.

Samples	GO (g)	HNT (g)	$FeCl_3 \cdot 6H_2O$ (g)	$FeSO_4 \cdot 7H_2O$ (g)	NH_4OH (mL)	FHGC	Yield
FHGC-1	0.8	0.8	2.0	1.22	24	1.8	79%
FHGC-2	0.8	0.8	1.0	0.61	24	1.5	73%
FHGC-3	0.8	0.8	0.5	0.31	24	1.2	67%

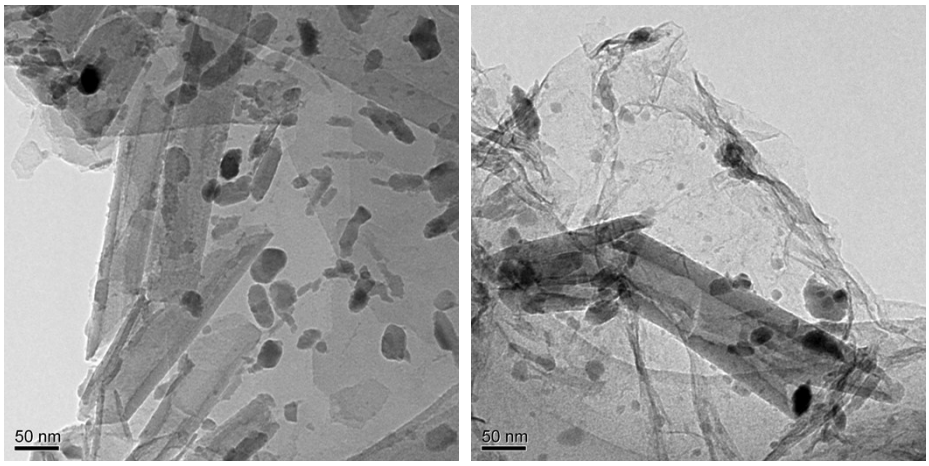
Table S1 Preparation conditions for the FHGC nanocomposites.



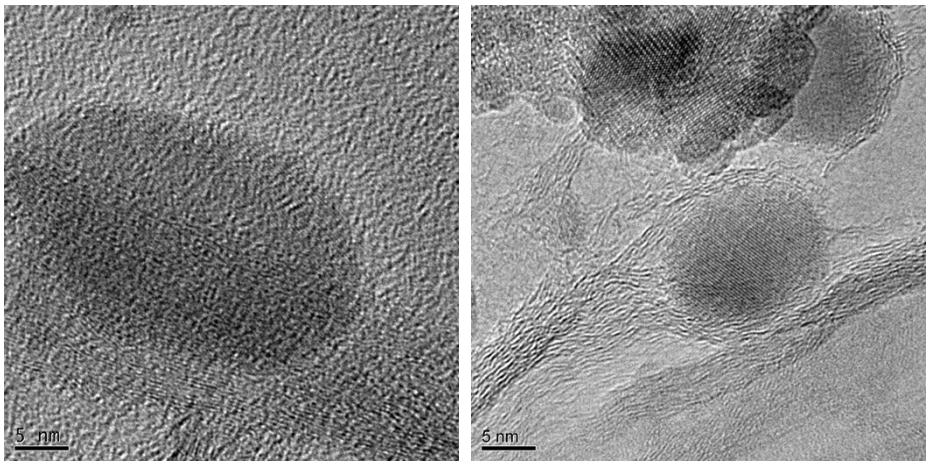
(a) (b)



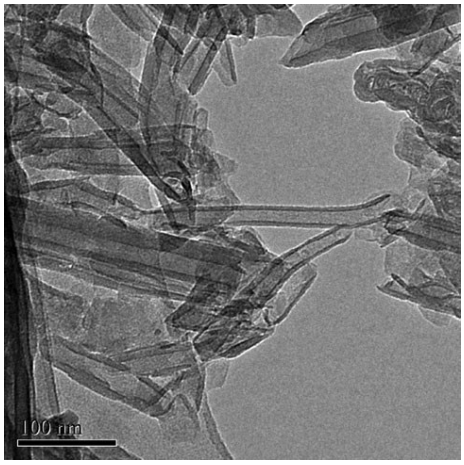
(c) (d)



(e) (f)

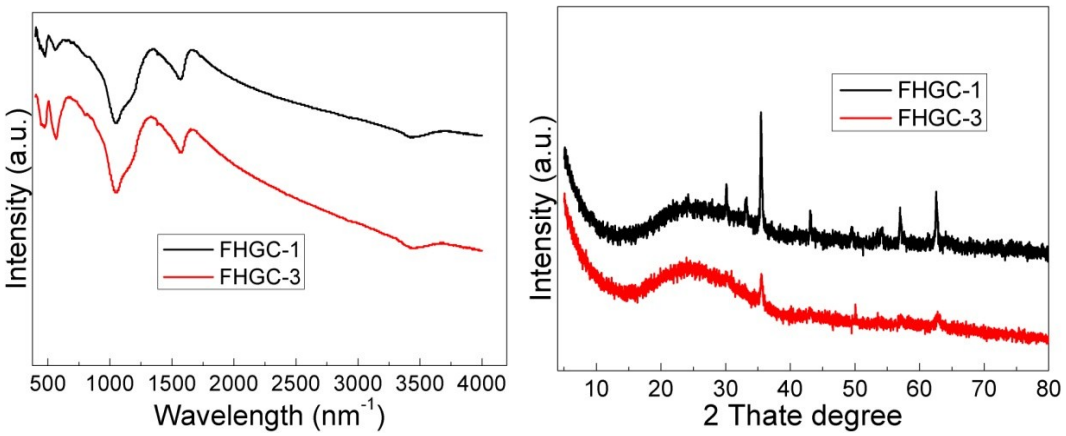


(g) (h)



(i)

Fig. S1. (a) and (b)TEM images of FHGC-1; (c) and (d)TEM images of FHGC-2; (e) and (f)TEM images of FHGC-3; (h) TEM image of Fe_3O_4 on HNT; (h) HRTEM image of Fe_3O_4 on rGO sheets; (i) TEM image of raw HNT.



(a) (b)

Fig. S2. (a) FT-IR spectra of FHGC-1 and FHGC-3; (b) XRD patterns of FHGC-1 and FHGC-3.

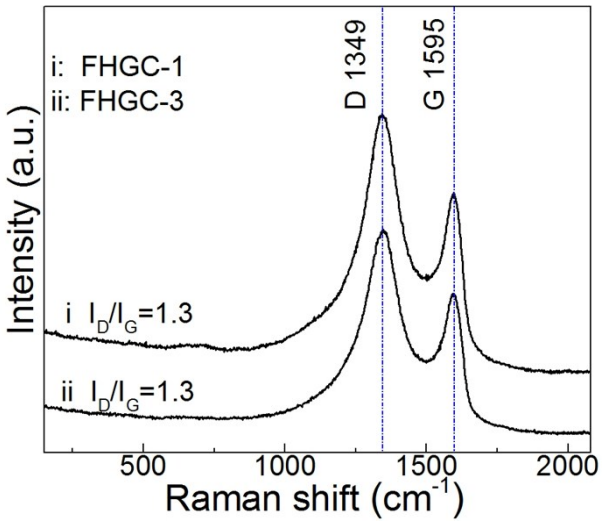


Fig. S3. Raman spectra of FHGC-1 and FHGC-3.

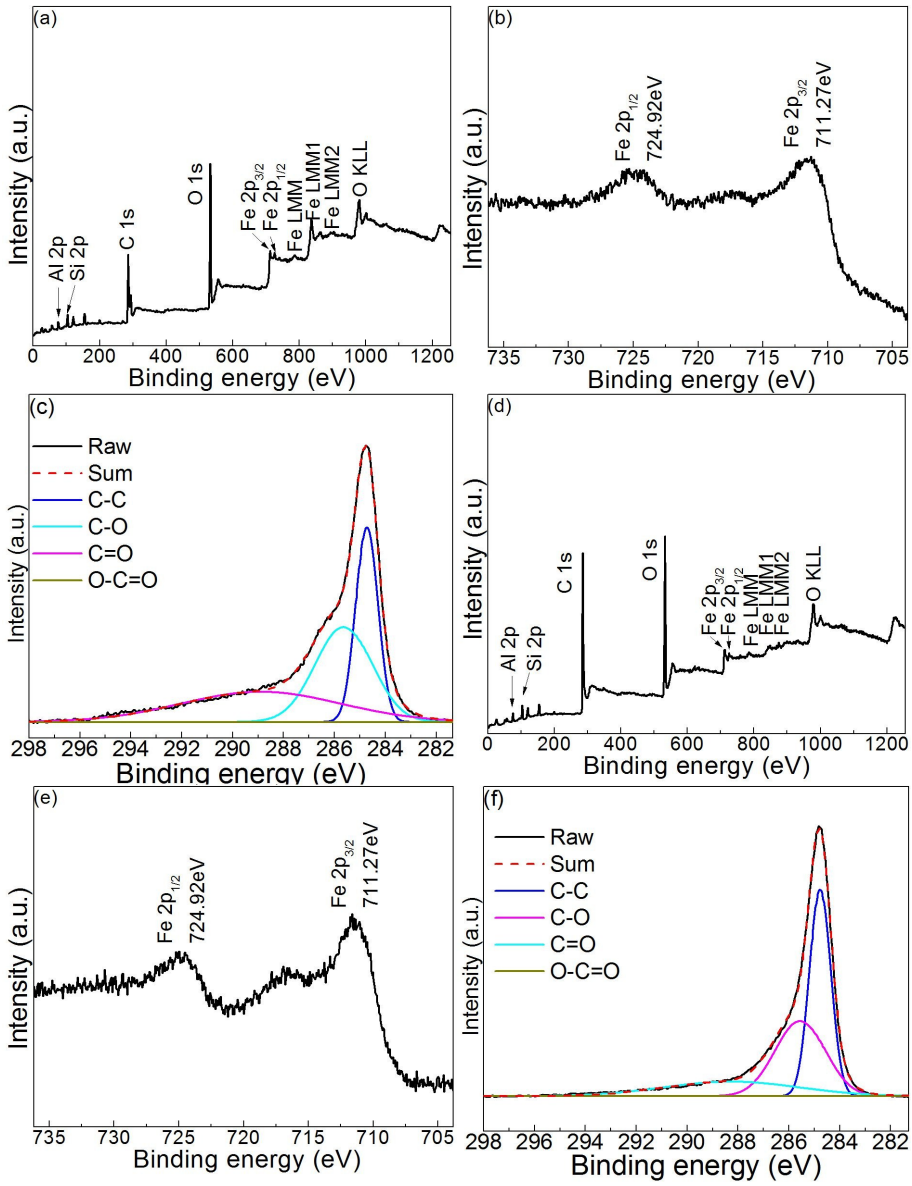


Fig. S4. (a) and (d) XPS spectra of FHGC-1 and FHGC-3; (b) and (e) is the high spectra of Fe of FHGC-1 and FHGC-3; (c) and (f) is the high spectra of C 1s of FHGC-1 and FHGC-3.

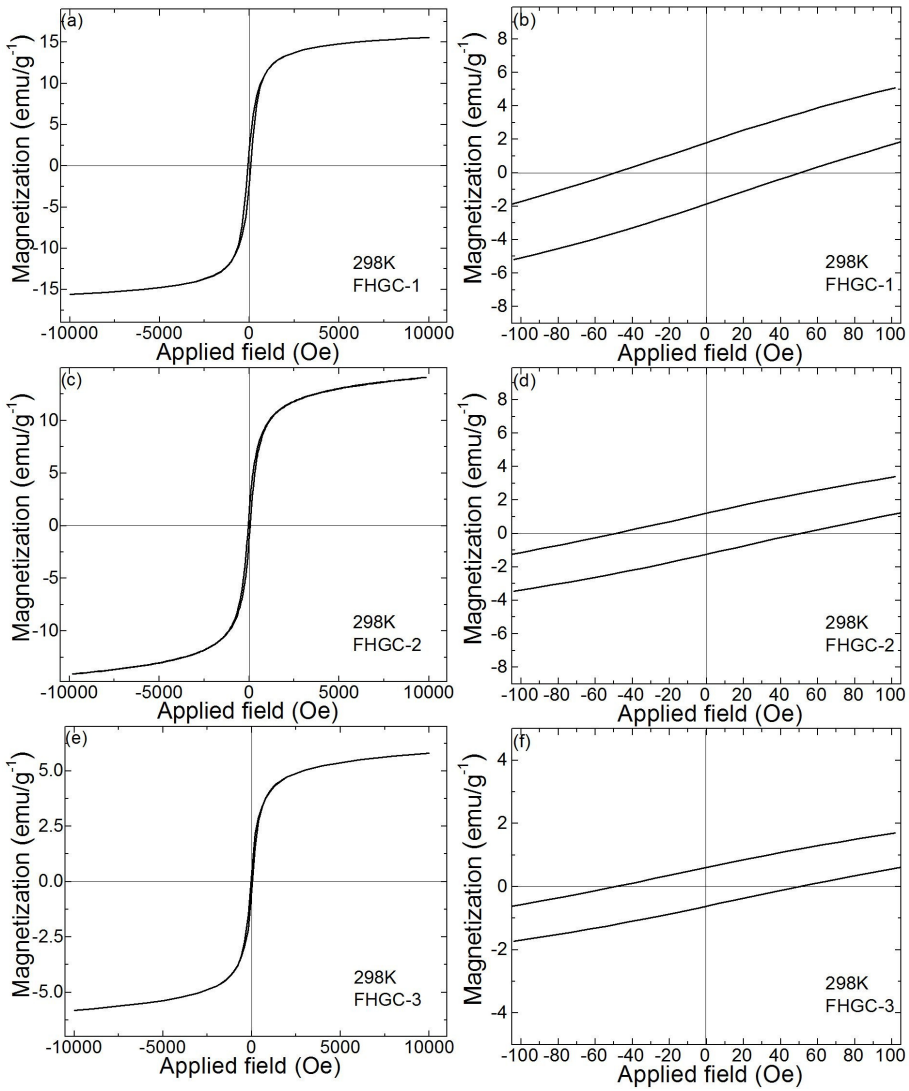


Fig. S5 (a) and (b) Magnetization curves for the FHGC-1, (c) and (d) Magnetization curves for the FHGC-2, (e) and (f) Magnetization curves for the FHGC-3.

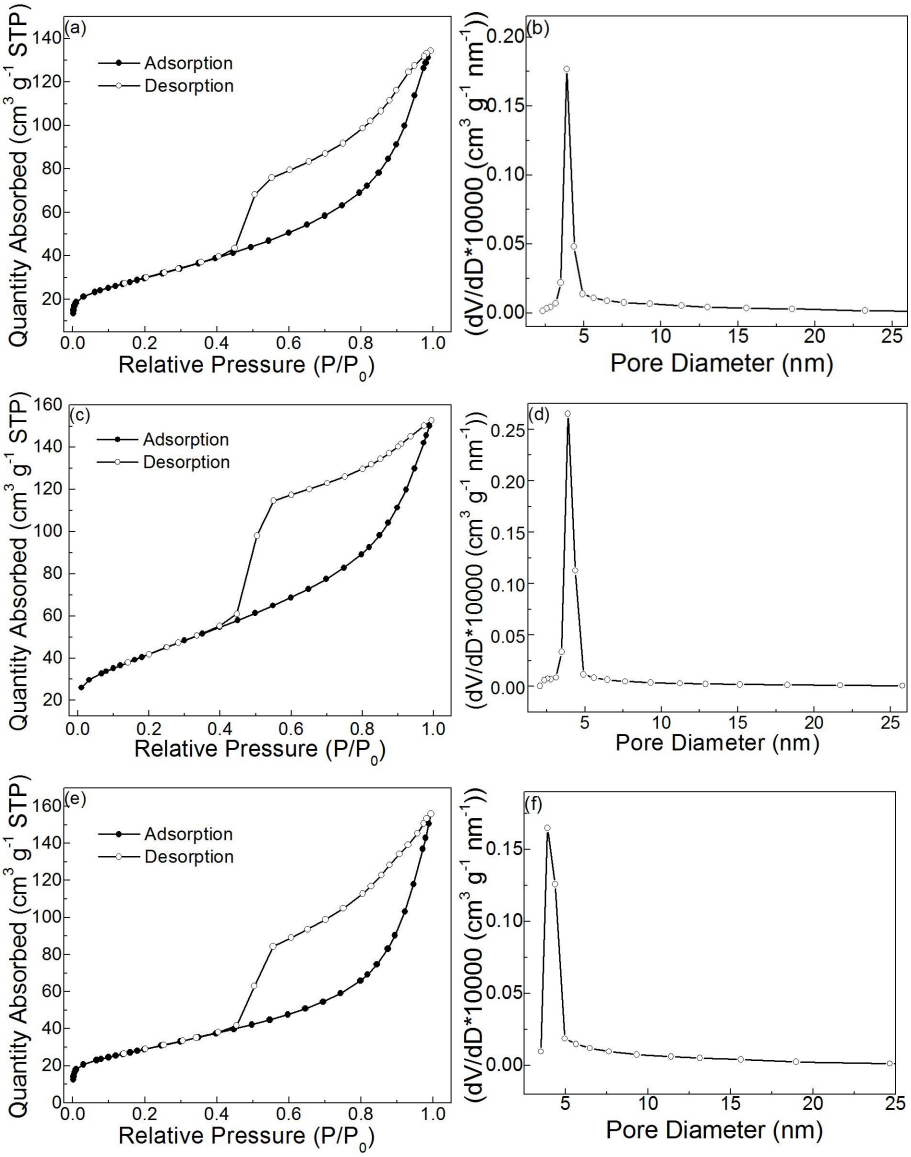


Fig. S6. (a), (c) and (e) Nitrogen adsorption desorption isotherms at 77K and (b), (d) and (f) pore width distribution of FHGC-1, FHGC-2, FHGC-3.

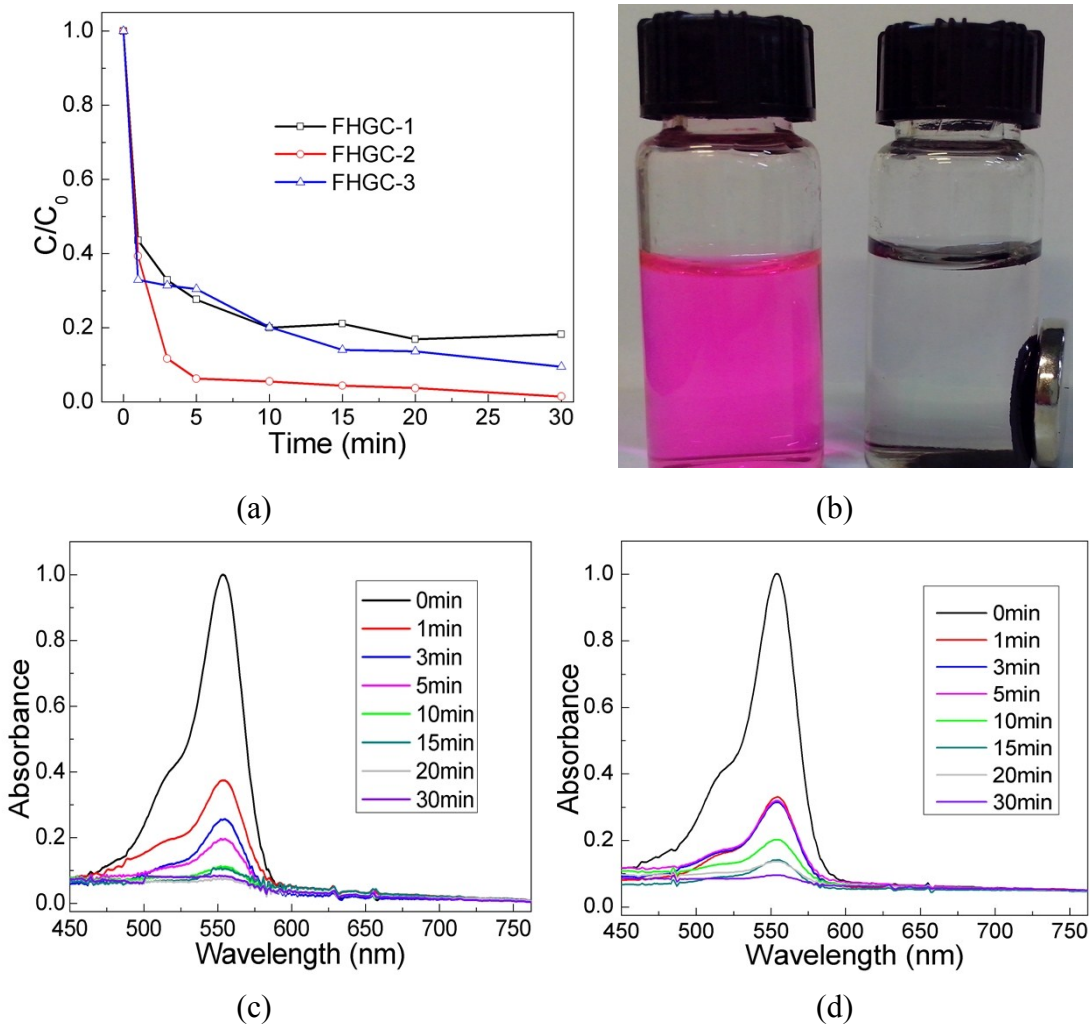


Fig. S7. (a) C/C_0 versus time plots with FHGC-1, FHGC-2, and FHGC-3 at various times. (b) photograph for the RhB solution ($1.0*10^{-5}$ M, left) and for FHGC and RhB solution with applied magnetic field (right). (c) UV-vis spectra of the original RhB solution ($1.0*10^{-5}$ M, 20mL) and those after treatment with FHGC-1 (50 mg) at different times. (d) UV-vis spectra of the original RhB solution ($1.0*10^{-5}$ M, 20mL) and those after treatment with FHGC-3 (50 mg) at different times.

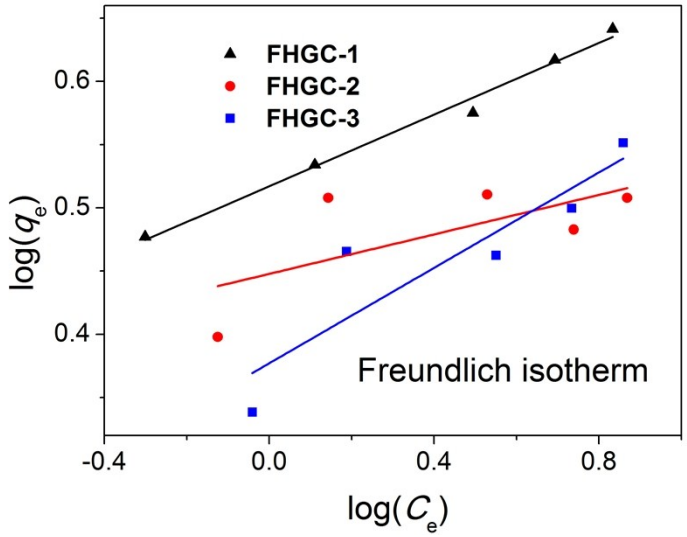


Fig. S8. Linearized Freundlich isotherm for As(V) adsorption of the FHGC-n (n = 1, 2, 3) samples.

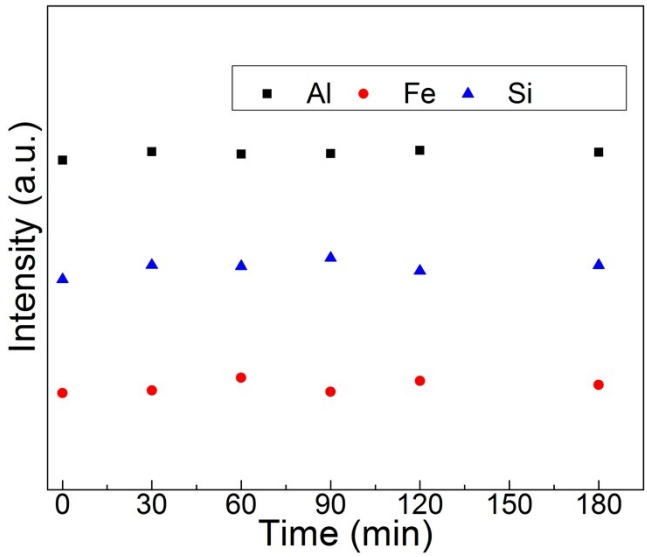


Fig. S9. Concentrations of Fe, Al, and Si during the adsorption process in the mixture system.

FHGC-1	As(V) Langmuir isotherm	q_m(mg g^{-1})	4.42
		K_L(L/mg)	2.09
		R^2	0.957
	As(V) Freundlich isotherm	n	7.06
		K_F($mg^{1-(1/n)}$ $L^{1/n}$ g^{-1})	3.29
		R^2	0.985
FHGC-2	As(V) Langmuir isotherm	q_m(mg g^{-1})	3.23
		K_L(L/mg)	9.54
		R^2	0.996
FHGC-3	As(V) Langmuir isotherm	q_m(mg g^{-1})	3.68
		K_L(L/mg)	1.37
		R^2	0.969
parameters of arsenic adsorption kinetics			
Sorbent	isotherm constant		As(V)
FHGC-1	q_e		3.70
	k_2		0.098
	V_0		1.34
	R^2		0.997
FHGC-2	q_e		2.78
	k_2		0.30
	V_0		2.33
	R^2		0.996
FHGC-3	q_e		2.59
	k_2		0.20
	V_0		1.37
	R^2		0.966

Table S2. Equilibrium adsorption isotherm fitting parameters for As(V) in cases FHGC-n (n = 1, 2, 3), and parameters of a pseudo-second-order kinetic model fitting arsenic adsorption kinetics in cases FHGC-n (n = 1, 2, 3)**.**

References

S1. W. S. Hummers and R. E. Offeman, *J. Am. Chem. Soc.,* 1958, **80**, 1339–1339.